Towards the Concordant Integration of Airport Expansion into Urbanization

Using the Berlin Brandenburg Airport Region as a Case Study

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Zusammenfassung

Die Luftfahrtbranche ist eine der führenden Kräfte regionalen Wirtschaftswachstums. Weltweit finden vermehrt luftfahrtbezogene Umwandlungen in der Nachbarschaft von Flughäfen statt. Gemeinden neben Flughäfen bilden Schnittpunkte großartiger Möglichkeiten und Herausforderungen; wenn ein neu ausgebauter Flughafen in Betrieb genommen wird, fließt z. B. eine große Menge an sozialen, öffentlichen und privaten Geldmittel ins Flughafengebiet und ändert somit dessen Wirtschaftsstruktur sowie Flächennutzung innerhalb kürzester Zeit.

Abgesehen von kleineren politischen Auswirkungen von städtischen Entwicklungsprojekten sind demografische Änderungen und Änderungen der Flächennutzungsverteilung von großangelegten Flughafengebieten durch den Einfluss des benachbarten Flughafens relevant. Daher sind Ermittlungen zur Beziehung zwischen Flughafenauswirkungen und Änderungen der städtischen Raum-, Wirtschafts- und Sozialstrukturen, basierend auf Fallstudien von ähnlichen Flughäfen als Planungsvoraussetzungen für angemessene Zukunftsentwicklungs-projekte in Flughafengebieten von Bedeutung.

Lineare Regressionsanalysen finden als statistische Modellen ausgedehnte Verwendung in akademischen und praktischen Feldern, um Korrelationen zu erforschen und Tendenzen vorauszusagen (Langzeitbewegungen in Zeitreihen). Lineare Regression wurde bisher ebenfalls verwendet, um die Auswirkung von Veranstaltungen bezüglich Städten vorherzusagen, zum Beispiel die der Olympischen Spielen auf die Wirtschaftsentwicklung der Gastgeberstädte. Basierend auf Fallstudien von Europäischen Eingangsflughäfen (London-Gatwick, London-Heathrow, Paris-Charles-de-Gaulle, Paris-Orly, Flughafen München, Flughafen Frankfurt, Amsterdam-Schiphol und Flughafen Zürich) führt diese Dissertation lineare Regressionmodelle ein, um die Korrelationen zwischen Flughafenkapazität und deren Auswirkungen auf die Demografie (Bevölkerungsdichte, Rate der alternden Bevölkerung und Arbeitslosigkeitsrate) sowie die Tendenz von Änderungen in der Flächennutzung der benachbarten Region zu erforschen. Schließlich werden Regressionsresultanten benutzt, um die demografischen Änderungen und Flächennutzungsänderungen auf dem Gebiet des Internationalen Flughafens Berlin-Brandenburg (BER) zu prognostizieren. Ein Umsetzungsbeispiel dafür wird ebenfalls formuliert.

Anwendungen des GIS (Geoinformationssystem) erlauben Nutzern, räumliche Informationen intuitiv zu analysieren. In der vorliegenden Dissertation werden ArcGIS Hot-Spot-Analysen und Dichtenanalysen eingeführt, um die gemeinsamen Grundlagen der

Flächennutzungsverteilung am Beispiel von Fallstudien Europäischer Flughafengebieten zu ermitteln. Diese beinhalten bspw. das industrielle und gewerbliche Cluster von Bodenverkehrskorridoren eines Flughafens; das Auswirkungsspektrum des Flughafens auf verschiedene Flächennutzungen; die Flughafenlärmbelastung hinsichtlich der Entwicklung benachbarter Wohngebieten etc.

Des Weiteren werden die Resultate in einen Kontext mit dem gegenwärtigen Zustand der Gemeinden im BER-Flughafengebiet gestellt, um die potenziellen Entwicklungshotspots für Planung und Stadtdesign-Strategien in diesem Gebiet einzuschätzen.

Die Ermittlung von Strategien für die Neueinrichtung des Stadtbilds und Stadt-Branding sind ebenso wichtige Teile dieser Arbeit. In der Zeit der Wissensökonomie spielen Stadtbild und Stadt-Branding eine wichtige Rolle in der städtischen Revitalisierung, insbesondere im Gebiet eines neuen Flughafens. Im Fall des BER-Flughafengebiets ist eine von den örtlichen Behörden entworfene „mentale Stadt“ noch wichtiger als die Bedingungen der „physischen Stadt“. Ein angemessenes Stadtbild, gefolgt von effizienter Planung und Designstrategien, könnte nicht nur das Vertrauen und das Zugehörigkeitsgefühl der Einwohner stärken, sondern auch die Wettbewerbsfähigkeit stark fördern, auf regionalem sowie auf Gemeinde-Niveau. Daher sind die Ermittlung eines angemessenen Stadtbilds für ein Flughafengebiet sowie Strategien für die Etablierung eines solchen Bildes wichtige Komponenten der vorliegenden Dissertation.

Abstract

The aviation industry is one of the leading forces of regional economic growth. Aviation-related urban transformation in the airport vicinity has been occurring at an increasing rate worldwide. Communities adjacent to airports represent intersections of great opportunities and challenges. For example, when a newly expanded airport starts operating, a large amount of social, public and private funds will forthwith flow into the airport region, thus changing the economic structure and land use distribution within a short period.

Disregarding political impacts of urban development projects in the small scale, the demographic and land use distributions of larger-scale airport regions are under common impact of their adjacent airports, since obvious aviation-related airport regions are formed with similar land use and demographic features. Thus, investigations on the relationship between airport impacts and changes on urban spatial, economic and social structure, based on case studies of similar airports, are significant as planning preconditions for proper future development projects in airport regions.

Linear regression analysis as a statistic model is widely used in academic and practical fields to investigate correlations and predict tendencies (long-term movements in time series). Linear regression has also been applied to predict the impact of events on cities, such as that of the Olympic Games on the economic development of the host cities. Based on case studies of European gateway airports (London Gatwick, London Heathrow, Paris Charles de Gaulle, Paris Orly, Munich Airport, Frankfurt Airport, Amsterdam Schiphol and Zurich Airport), in this thesis are introduced linear regression models to investigate the correlations between airport capacity and its impacts on demographics (population density, aging population ratio and unemployment ratio), and the tendency of land use changes in the neighboring regions. At last, significant regression resultants are used to predict the demographic and land use changes in the Berlin Brandenburg (BER) international airport region, and an implementation example is given.

GIS (Geographic Information System) applications allow users to analyze spatial information in an intuitive way. In this thesis, ArcGIS hot spot analysis and density analysis are introduced for investigating common grounds in land use distribution, using case studies of other European airport regions. These include, for instance, the industrial and commercial cluster of an airport's ground traffic corridors; airport impact range on diverse land usage; airport noise impact on the adjoining residential development; etc. Next, resultants are correlated with the status quo of communities in the BER airport region to estimate the potential development hot spots for planning and urban design strategies in this area.

The investigation of strategies for re-establishing urban image and urban branding is also an important part of the present work. In the knowledge-based economy era urban image and urban branding play an important role in urban revitalization, especially in a new airport region. In the case of the BER airport region, a “mental city” outlined by the local authority is even more important than the existing conditions of the “physical city”. A proper urban image accompanied by efficient planning and design strategies may not only retain the confidence, reputation and the sense of belonging of local residents, but also highly promote competitiveness at both regional and community level. Therefore, investigation on a proper urban image for an airport region, as well as strategies for establishing such image, is also an important component of this thesis.

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1 Introduction

1.1 Background

1.1.1 Air transportation – The New Era of Transportation

There are five waves of urban development evolving from the history of transportation-induced urban growth. The advancement of seaports and waterways a hundred years ago originated wealthy, harbor-centered cities, whereas railway expansion in the 18th and 19th centuries gave rise to today's railway networks and transformed railway-transection cities into the first metropolises. Highway development in the 20th century marked the era of automobiles, and pushed forward the trends of suburbanization. In the 21st century, air transportation has become the new engine for economic development, and major gateway airports generate spatial concentration of commercial activities that lead to a brand-new aviation-related urbanization tendency[1]. Each turn of the revolution of transportation technologies has greatly changed the patterns and structures of our cities, and it is a fact that the traffic infrastructure plays an indispensable role in urban development.

The impact of air transportation on economic activities differs from that of other transportation modes because of its distinctive characteristics, such as speed, cost, flexibility, reliability and safety. It is a unique feasible, long-distance transportation mode for high-value perishable commodities and time-sensitive people, and is often the sole means of access to geographically isolated areas[2]. Owing to these features, air transportation has enhanced the globalization and made sourcing and sales between long distances become reality; it formed the new international supply-chain management system, and generated the commercial time-based competition mode. As a result, speed and agility have become as important as price and quality as concerns competition: businesses can sell to and purchase from anyone, anywhere in the world; people want customized products, and want them quickly. Demand and supply conditions have changed rapidly and in

[1] Kasarda John, "From Airport City to Aerotropolis.pdf," Airport World 6, no. 4 (August 2001): 42–47.

[2] Mariya A. Ishutkina, "Analysis of the Interaction between Air Transportation and Economic Activity: A Worldwide Perspective" (Massachusetts Institute of Technology Cambridge, MA 02139 USA, 2009), 27.

unpredictable ways.

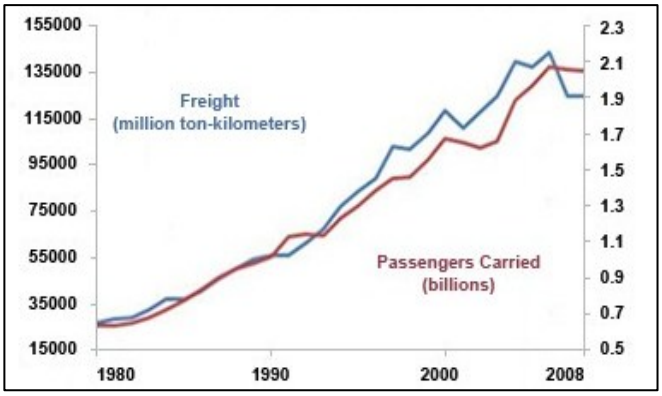

Figure 1-1 Freight/Passengers carried worldwide (1980-2008)

Source: The World Bank Group. http://web.worldbank.org

A boom in air transportation occurred alongside a rapidly increased amount of air passengers and air freights. Figure 1-1 shows that the total air passenger and air cargo volumes have also been rapidly increasing since the 1980s. Passenger numbers worldwide have grown by 45% over the last decade and have more than doubled since the mid-1980s. Freight traffic has increased even more rapidly, by more than 80% over the last decades on a performed ton-kilometer basis, and almost three-fold since the mid-1980s. In 2004, the air transport industry carried 1,890 million scheduled passengers and 38 million tons of freight[3].

1.1.2 The Emergence of Airport City and Aerotropolis

Modern airports include not only aircraft-operating functions like control towers, terminals and runways, but are also becoming luxurious shopping malls, artistic and recreational venues for pursuing economic benefits. Moreover, regions surrounding these airports are clustered by time-based industries like logistics, just-in-time manufacturing, high-technology industries, business services and regional headquarters, etc. Meanwhile, other non-aeronautical facilities like exhibition centers, offices, retail complexes and free-trade zones have accumulated around airports. Hence, major airports are no longer only known as urban infrastructures, but also as cores of new urban developments. This formation in and around major airports is referred to as “Airport City”. The airport itself and its connected urban regions constitute the so-called “aerotropolis”.

It is worth mentioning that, in recent years, many researches have been performed investigating the development modes of airport cities and aerotropolises. The most significant researcher of this field is Prof. Dr. John Kasarda, from the Kenan-Flagler Business School, University of North Carolina. Pioneer of airport city researches, Dr. Kasarda has stated, about the airport city model, that “larger airports are thus taking on

[3] *Annual Report of the Council 2008* (International Civil Aviation Organization (ICAO)), 2009), 7.

features of metropolitan central business districts, increasingly operating as points of multimodal surface transportation convergence with surrounding office, hotel and commercial facilities[4]". He also defined aerotropolis as "an urban complex whose layout, infrastructure and economy are centered on an airport. Analogous in shape to the traditional metropolis made up of a central city and its rings of commuter-heavy suburbs, the aerotropolis consists of an airport city core and outlying corridors and clusters of aviation-linked businesses and associated residential developments[5]".

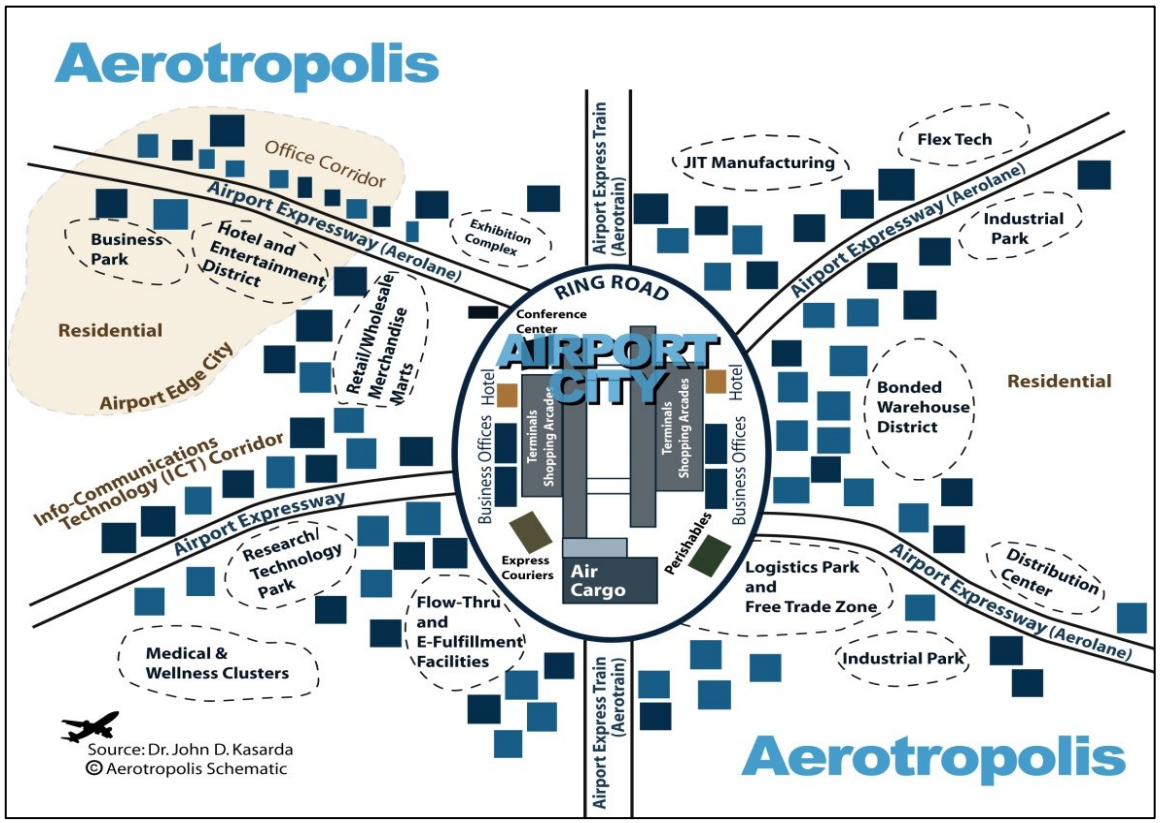

Figure 1-2 Aerotropolis scheme.
Source: Airport Cities, Urban Land, April 2009, P60

Figure 1-2 shows the basic structure of an airport, airport city and aerotropolis. The passenger terminal is as a core of urbanization and is surrounded by the airport city, which is formed by most aviation-related firms and facilities. Normally, airport and airport city are considered as an integrated commercial mode, and operated by a defined management firm. In the planning field, the airport city is also integrated in an airport plan. Aerotropolis is a more general concept with no defined boundary, and is explained as the expansion of the airport city. An aerotropolis is composed by airport-surrounding localities with

[4] Rosário Macário, "Airports of the Future: Essentials for a Renewed Business Model," *European Journal of Transport and Infrastructure Research* 8, no. 2 (2008): 2.

[5] John Kasarda, "Aerotropolis: The Way We Will Live Next?," *Atlantis*, December 2011, 12.

advantageous traffic linkages. It is composed not only by business facilities, industrial parks and warehouses, but also by compound urban functions, like residence and social service facilities such as leisure, education, medical and wellness clusters for supporting local residents, air passengers and airport employees. Because of the administrative division, local authorities of each community in the aerotropolis region are more powerful in making decisions concerning the further development in their territories. Therefore, there is a rare compound in aerotropolis planning that considers the area as a whole. As the intersection of all challenges and opportunities generated by the airport, and facing the most direct impacts by it, the strategy for an aerotropolis should consist of local plans at different administrative levels, and concordantly integrate solutions for diverse airport impacts.

Nevertheless, although airport cities have been widely scrutinized, no studies exist yet that could be considered a supportive reference for planning of airport-surrounding communities.

First, airport cities and aerotropolises are business models, but not planning or urban design concepts. They only discuss the business structure and economic activities surrounding an airport, but do not regard living quality, noise, air pollution and other non-economic impacting factors. Therefore, they do not serve as a comprehensive guidance in urban spatial planning.

Second, the concept of airport city implies a term for an "inside-the-fence" airport area including the airport itself (terminals, apron and runways) and on-airport businesses, such as air cargo, logistics, offices, retail and hotels. Thus, it is more an airport-related business concept than an urban notion, and its range is too small to describe the situation of a wider-scale airport-surrounding region.

1.1.3 Airport Region – the Intersection of Challenges and Opportunities

The airport nowadays replaces the role of a sea harbor or railway terminal in catalyzing the urbanization in its surrounding region. In the Victorian age, the flourishing of railway progress in England has greatly improved economic developments in cities around railway terminals or along railways, thus promoting the urbanization of these cities. William Title, the engineer for the extension from Nine Elms to Waterloo, described the railway's primary

effect as that of "giving new frontages and new opportunities for building[6]". Cities like London, Birmingham, Liverpool and Manchester became the most well-known industrial cities in the world, and highly clustered with population from the countryside. Railways have also changed the existing urban structure and land use distribution of these cities. "Places for refreshment and entertainment, for eating and lodging, and for retail shopping, gathered conveniently around the terminus. Squares or streets where the main passenger terminals were situated presented an obvious confluence of people and traffic, which resulted in a rising demand for sites of all descriptions around the station."[7]

Like the railway in Victorian cities, airports are now the leading power of urbanization of its connected cities. Airport-surrounding communities have become the new clusters of urban development. The impacts from airports on these communities are explained as positive effects like economic and social benefits, and negative ones such as noise, water and air pollution, safety concerns, etc. Moreover, when considering impacts from airports on surrounding communities, they are not only direct ones from the airport, but also indirect effects from surface traffic connections and large aviation-related facilities under airport influence.

- **Economic Benefits**

The economic benefits from airports to surrounding communities mainly include providing jobs and skill training; upgrading business competitiveness and attracting investments; and contributing with tax and charitable support.

The airport as the core of urban development brings jobs and skill training opportunities for airport-surrounding communities. New jobs include not only direct and indirect employment by the airport and firms serving the airport service supply chains, but also induced job opportunities for serving employees of direct and indirect occupations. Direct jobs could be seen, for instance, in statistics showing that the Paris Charles de Gaulle (CDG) Airport employs 65,000 people on site, making up 28% of the employees in the 63 communities located within 15 km of the airport[8]. In these inner areas, airport-related employment accounts for 39% of all jobs, up from 18% in 1975. This indicates the

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[6] John R. Kellett, The Impact of Railways on Victorian Cities, New Ed edition (London: Routledge, 2006), 175.

[7] John R. Kellett, The Impact of Railways on Victorian Cities, New Ed edition (London: Routledge, 2006), 176.

[8] Agence Minit-L, "L'impact économique des aéroports franciliens - Entrevoisins.org," accessed September 22, 2014, http://www.entrevoisins.org/eco_social/impact-economique-aeroports-franciliens/default.aspx.

growing local importance of the airport. In another example, the London City Airport, which is located close to communities with high levels of unemployment, carries out a number of initiatives for recruitment and training to ensure that, as far as possible, jobs go to local people. There is a target that 70% of employees should come from this "local area", with priority being given to those living within 5 miles or 30-minute traveling distance to the airport. The airport itself exceeds this target, with 79.5% of employees coming from the area. It also undertakes a number of educational initiatives and is actively engaged with the community in developing the employability of the local workforce[9].

The study "The Social and Economic Impacts of Airports in Europe"[10] shows that airports are an essential factor in flourishing business development by influencing company location decisions and competitiveness. The presence of an international airport can be the critical factor in:

- Attracting new inwards investment from outside the area, especially companies from overseas;
- Retaining existing companies in the area, whether they had previously been inward investors or indigenous operations;
- Securing the expansion of existing companies in the face of competition with other areas;
- Promoting the export success of companies located in the area by the provision of passenger and freight links to key markets.

The survey "European Cities Monitor 2007[11]" shows that, based on statistics of questionnaires sent to 500 of the 1,500 largest European companies, an essential factor for locating a business is "easy access to markets", customers or clients for 58% of the enterprises, as well as "transport links with other cities and internationally" for 52% of them.

The Schiphol Airport is a good example to support the airport attractiveness to business development in its vicinity. The survey "Success Factors for the Airport City – the Schiphol Case"[12] shows that, until 2011, there were 500 companies located at the Schiphol

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[9] *The Social and Economic Impact of Airports in Europe* (Airport Council International (ACI), January 2004), 29.

[10] *The Social and Economic Impact of Airports in Europe* (Airport Council International (ACI), January 2004), 29.

[11] *European Cities Monitor 2007*, Report (London: Cushman & Wakefield-Global Real Estate Solutions, October 2007), 4.

[12] Joop Krul, *Succes Factors for the Airport City- The Schiphol Case* (Amsteradam NL: Schiphol Group, February 2011).

Airport, and 1,800 international companies in the Schiphol region. The percentage of business and companies stating that they are dependent on the airport was as shown in Table 1-1.

Sector of industry	Dependency rate on aviation
International Head Quarters	98%
International Transport & Distribution	88%
Large International Enterprises	82%
4 and 5 star Hotels	75%
Business and Financial Services	46%
Technology institutes	42%

Table 1-1 Rate of Amsterdam Industries Dependent on the Schiphol Airport
Source: Regional Survey VNO/ NCW 2008

Air transportation plays also an important role in supporting tourism. In Europe, tourism is considered an increasingly important sector in the economic development of many countries. As a whole, tourism accounts for 2.8% of employment, amounting to 11 million people. If transport and distribution trades are included, the figures rise to 30 million jobs and 8.2% of the total employment[13]. Airports play a major role in facilitating the development of tourism, particularly in the case of more remote or island destinations. For example, 70% of foreign tourists travel to the UK by air. Approximately 37% of visitors to Vienna also travel by air, and 32% of foreign tourists to the Lisbon area arrive through the Lisbon Airport[14].

A responsible airport operator also pays certain community funds to its neighboring localities, promoting a harmonic development between airport and these communities. For example, the BAA (Heathrow Airport Holding Limited), which operates the Heathrow Airport as well as a number of other UK airports like Aberdeen, Glasgow and Southampton, provides the "Communities Trust" and "Community Fund", which are charity grants to support and strengthen local communities close to airports in Aberdeen, Glasgow, Heathrow and Southampton. These grants also include "Communities for Youth", offering up to £25,000 to support young people in both their educational and skill developments; "Communities for Tomorrow", a program providing up to £25,000 for

[13] Rochelle Turner, *Travel & Tourism Economic Impact 2013* (UK: World Travel & Tourism Council, 2013), 3–5.

[14] *The Social and Economic Impact of Airports in Europe* (Airport Council International (ACI), January 2004), 29.

projects that help protect the environment or encourage sustainable development and ecological education, being funded through aircraft noise fines; and "Communities Together", granting up to £25,000 for a wider range of smaller community-focused projects and being funded in part by donations from passengers at the Heathrow airport. These donations or trusts could not only provide financial support for the coordinated development of airport-surrounding communities, but also provide chances for communities to find expertise solutions for their revitalization.

- **Social Benefits from Airports to Surrounding Communities**

A new airport or a newly expanded airport can bring not only economic benefits to its region, but also social benefits, especially by promoting the life quality of surrounding communities.

First of all, a new airport enhances the surface traffic connections in the whole urban region. This was the case, for example, in the expansion of the Berlin Brandenburg International Airport. A large train station was built in the underground of the airport terminal, which will connect the new airport express and ICE (intercity express) trains from the airport not only to the city of Berlin, but also to the whole Europe. The newly expanded airport has also enhanced the regional transportation system, with the light rails system and new bus lines. This means that residents who work in Berlin and live between the airport and the city will have a more efficient and convenient access from their homes to workplaces.

Social benefits brought about by airports could also be seen, such as providing skill training. Airports contribution for decreasing the unemployment rate is more direct and more obvious to their surrounding communities than to their connected main city. It also has a more powerful impact on increasing purchasing power.

Airports also work in promoting service facilities and improving living standards by widening the choice in airport-encircling communities. Large gateway airports are commonly located in suburbs, but not in city regions. Existing communities surrounding airports are normally distant from the city center, with limited basic service facilities like schools, hospitals, universities, shopping area, etc. When a new airport is established nearby, it works like a magnet in attracting firms to settle on the airport site. As a result, more young families, such as employees of the airport or related firms, make their homes in the nearby communities. Moreover, business passengers of these airport-related firms also accommodate in them. This way, firms, residents and visitors give rise to a

reurbanization trend, and higher-grade service facilities are built to support these trends. For example, a higher-grade hospital means a more comprehensive health care potential; a university and galleries will bring more culture and scientific atmosphere; a large number of new restaurants, gyms, retail, and even cinemas will benefit the daily lives of local residents.

- **Noise Impact of Airport-Surrounding Communities**

Noise impact is the major negative repercussion of the aviation industry. Most public protests against airport developments are, in fact, against airport noise impacts on surrounding urban regions. Noise from airports is generally determined based on the aircraft type, the frequency of landings and takeoffs, and also the flight routes of aircraft activities. As a common rule, the larger the airport capacity, the greater the noise impact it brings. Noise pollution not only affects people's health, but also decreases property value in communities near airports.

The effects of noise pollution on people's health can take in many forms, such as[15]:

• Loss of concentration;

• Sleep disturbance;

• Anger, frustration and powerlessness to control the noise;

• Fear of accidents and of potential increases in the frequency of the noise;

• Cardiovascular disease;

• Mental health disturbance (may affect, but not cause it);

• Diminished educational achievement (due to either direct effect or loss of teaching time due to noise disruptions);

• Hypertension and ischemic heart disease;

• Adverse effects on performance, e.g. reading, attentiveness, problem-solving ability and memory; deficits in performance can also lead to accidents;

• Noise above 80 dB may increase aggressive behavior;

• Hearing impairment, i.e., the inability to understand speech under normal conditions, which is considered a severe social handicap and the main social consequence (WHO, 2001) of noise pollution.

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[15] "Airport Planning Guide" (Aviation Environment Federation UK, 2006), 2–7, http://www.aef.org.uk/uploads/PlanningGuide2.pdf.

Noise has also negative impacts on the land value of airport-surrounding localities. Some have speculated that the convenience and economic revenues from an airport serve to offset any diminution in value; however, nothing in the body of published literature supports this notion. In fact, this has been directly dispelled in an article published in the Journal of Transport, Economics and Policy, which utilizes hedonic regression to show that NNI50 properties sustain a diminution in value ranging from approximately 7%-12%[16].

One of the most important studies published to date was conducted for the US Federal Aviation Administration in 1994. It evaluated three airports using a regression analysis: Baltimore/Washington International Airport (BWI), Los Angeles International Airport (LAX), and John F. Kennedy Airport in New York (JFK). The results indicated a consistently negative impact on residential property market values. For example, the BWI study regarded homes near airports that would have a market value loss ranging from -$627 to -$14,595 per home. The LAX study indicated that losses of the total home market value ranged from -0.8% for low-priced homes to -15.7% up to -19% for moderately priced ones. The JFK study includes low-, moderately and high-priced residences. It indicates a loss of 0.12% per dB(A) (A-weighted decibel) for low-priced homes, -0.46% per dB(A) for moderately priced ones, and 1.35% per dB(A) for high-priced residences[17].

■ Air Pollution and Water Pollution

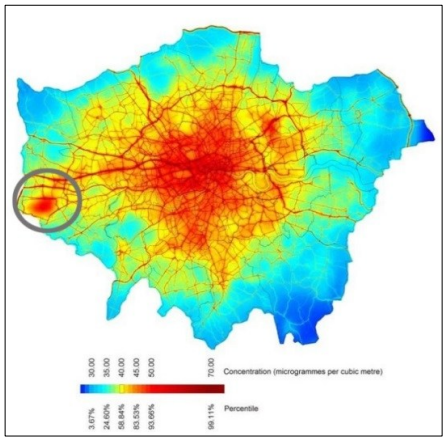

Figure 1-3 PM 2.5 Particulate Air Pollution in London, 2008
Source: www.gov.uk/thelondonplan

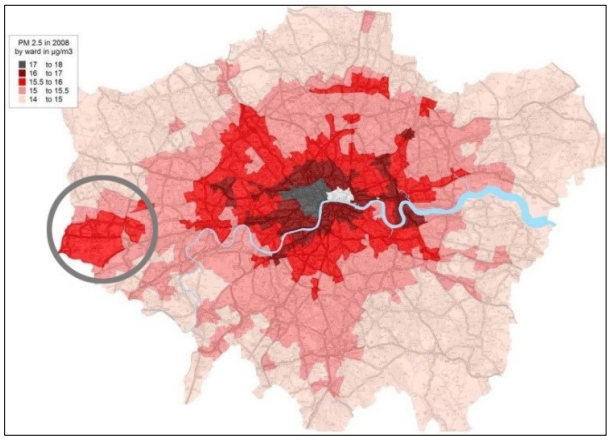

Figure 1-4 Modeled 2003 Annual Mean NO_2 Concentrations in µg/m³
Source: www.gov.uk/thelondonplan

[16]Bell Randal, The Impact of Airport Noise on Residential Real Estate." Retrieved Sept. 2014, http://www.thefreelibrary.com/The+Impact+of+Airport+Noise+on+Residential+Real+Estate.-a078238409

[17] Booz-Allen & Hamilton, Inc, The Effect of Airport Noise on Housing Values: A Summary Report, Office of Environmental and Energy Federal Aviation Administration, 1994, 17.

A study of the Aviation Environment Federation UK indicates[18] that the air quality in Heathrow is particularly bad, and the government has stated that it will only permit the development of a third runway at Heathrow Airport if it is confident that air quality limits can be met. Overall, the area of sensitive ecological habitat where acid deposition and atrophying pollutants exceeded critical loads have also fallen over time, but in 2003, 56% of these habitats still received much acid deposition, and 59% much atrophying pollution.

The construction work of airports and related facilities generates large amount of wastewater. Rainwater that falls on parking lots, building roofs, runways and other hard surfaces will run off either into drains or into nearby water bodies, thus causing the spoilage of ground water in an airport buffer zone, due to carrying along de-icing chemicals or leaked fuels[19].

- **Landscape and Culture/Heritage**

Due to the commercial opportunities an airport brings, a large preserved natural land will be occupied for further development. In addition, the airport ground accesses will also seize a large territory. This will change the existing landscape of the airport's surrounding communities. Trees or hedges might be replaced by new buildings and traffic lines, as might heritage architecture.

First of all, more buildings mean less green in existing communities. This will change not only the view of these communities, but also the land use, land form and land texture. It may also change the climate and microclimate of these localities.

Second, historical and cultural remains, both above ground and buried, such as historic buildings, cemeteries, parks, bridges, and canals and other structures of architectural or historic importance will be replaced in the wake of the airport progress. They can be razed or built over to make way for airport-related development; their structure might be affected by vibrations from aircrafts or road traffic; their materials may weather faster due to air pollution; and their curtilage or general landscape setting can be eroded, so that one can no longer view them in context.

[18] "Airport Planning Guide" (Aviation Environment Federation UK, 2006), 2–7.

[19] "Airport Planning Guide" (Aviation Environment Federation UK, 2006), 2–7.

1.1.4 Berlin Brandenburg International Airport and its Airport Region

■ **The Redevelopment of the Berlin Brandenburg International (BER) Airport**

Following the German reunification in 1990, Berlin once again became the capital of Germany. Berlin is also well connected to the rest of Germany, Europe and the world, offering 178 destinations in 49 countries in its 2012 flight schedule. In 2012, passenger figures at both commercial airports broke all previous records: for the first time, more than 25 million passengers were reported in a single year. With a year-on-year increase of 5.1%, air traffic in the Berlin-Brandenburg region thus outpaced the average international commercial airport in Germany (up approx. 1.1% in relation to 2011) for the tenth consecutive year. This enabled Berlin-Brandenburg to consolidate its third-place position in the ranking of air traffic locations in Germany[20]. Plans were made to recognize the increased importance of the region with the construction of a large commercial airport, as the existing Tegel and Schoenefeld airports were reaching their maximum capacities due to the increasing number of passenger and air freights. A single airport concept was pursued in order to ensure the economic viability of the project. This meant that the new airport would become the sole commercial airport for the states of Berlin and Brandenburg. As a consequence, it was decided to have Tegel, Schoenefeld and Tempelhof closed upon opening of the new airport.

On 28 May 1996, Eberhard Diepgen, Manfred Stolpe (then Governor of Brandenburg) and Matthias Wissmann (then Federal Minister of Transport) committed themselves to Schoenefeld as the site of the new airport[21]. This so-called consensus decision making was later confirmed by the respective state legislatures. The airport would even use certain infrastructure, like a runway, from the current Schoenefeld Airport. Henceforth, the airport would be planned, owned and operated by the BBF Holding (which was renamed to Flughafen Berlin Brandenburg GmbH (FBB) shortly afterwards), which in turn is owned by Berlin and Brandenburg (37% each), and Germany (26%).

On 24 November 2011, operating tests and service trials commenced. This phase also regarded the acceptance tests of various airport systems. On 8 May 2012, it became clear that the opening date would not be met due to failures in the fire protection system. All

[20] *Press Kit-Berlin Brandenburg Airport* (Berlin Germany: Flughafen Berlin Brandenburg GmbH, September 2014), 3.

[21] *Press Kit-Berlin Brandenburg Airport* (Berlin Germany: Flughafen Berlin Brandenburg GmbH, September 2014), 3.

trials were halted and have not been resumed so far.[22] As of February 2014, the BER Airport had still not been inaugurated, and the presumed opening date is unknown.

- **BER Airport Impact on its Surroundings**

As the most expensive construction project in Germany[23], many works have been done or are planned to ensure the airport as a motor for regional and sub-regional economic progress and regional competitiveness of the Berlin and Brandenburg metropolitan region. For example, the ground traffic accesses of the new airport site have been enhanced. A six-track railway station has been integrated into the underground level of the new terminal building; new light rail (S-Bah) lines, highway joints, as well as bus lines are planned to enhance the transportation capacity for facing the increasing number of airport passengers. A corresponding airport city has been planned surrounding the airport to meet the requirements of airport passengers. Large-scale business parks and logistic centers have also been planned along the traffic corridors BER-Berlin and BER-Potsdam, in order to enhance the development of aviation-linked industries.

Back to the urban development of the BER airport region, the airport is expected to bring development opportunities. In fact, even though the airport has not started to operate yet, the aviation-related economic developments are already visible in the whole airport region. Many large international companies have moved from the city of Berlin to this area, and many new airport-related businesses have also settled here. For example, in 2008 Rolls-Royce started building a new Mechanical Test Operation Center (MOTC) in Dahlewitz, a district of Blankenfelde- Mahlow. Further, Siemens has invested 66 million Euro to establish a combustion test center for gas turbines. The new test center, which is being built on a 36,000-square-meter (m^2) site, will play a key role in advances and developments for gas turbines.

However, the living quality and life style of residents in the airport-surrounding communities will undoubtedly be affected by the new neighboring airport. Most of the airport impacts on living quality are considered negative. According to a questionnaire by the Goettinger Institute of Demography[24], 96% of a total of 708 respondents who live in the BER Airport region are against the planned flight routes of the airport. For 93% of the

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[22] *Press Kit-Berlin Brandenburg Airport* (Berlin Germany: Flughafen Berlin Brandenburg GmbH, September 2014), 3.

[23] *Press Kit-Berlin Brandenburg Airport* (Berlin Germany: Flughafen Berlin Brandenburg GmbH, September 2014), 3.

[24] Ana Becke et al., *Protests Against the Berlin Brandenburg Airport (in German)* (Göttingen Germany: Göttinger Institut of Demography, August 2011).

708 respondents, airport noise is the major reason for protesting against the expansion project. They also believe that the aircraft noise will drastically decrease the land value of their property, as well as cause damages to health and living quality of their communities.

Therefore, similar to other large international airports, the new BER airport region is also the intersection of development opportunities and problems, and will become the new urban development hot spot in the whole Berlin-Brandenburg region. Based on a comprehensive analysis of case studies of similar regional developments in existing airports, it is very significant to create proper urban development strategies for the new BER airport regions to better understand the correlation between airport impacts and the demographic and land use variations of its periphery.

1.2 **Purposes and Specific Questions of the Study**

With the background stated above, the purposes of the study have been established, and several questions have been raised as the specific focus of the study.

- **To Investigate on Correlation and Quantification of Airport Impact on Demographic Variations in the Airport Region**

In urban study field, demographic structure is one of the most important factors that influence on decision making and city planning. Population density, percentage of aged population, as well as unemployment ratio (employment to population ratio) interprets the urban competitiveness, attractiveness and economic status. They as well determine the demand characteristics of different social service facilities, and as well reflect the trends of land-price fluctuations. Therefore, for decision makers, city planners and related experts, a better understanding of the correlation between the airport impacts as reasoning, and the demographic variation as consequences, is significant for them to make proper strategies for the urban development of new airport regions.

Obviously, demographic variations of airport regions are consequences of diverse influence factors. However, after a comparative study of airport impacts and demographic variations in different European airport regions, the author found, several airport impact factors have direct correlations to demographic variations. In other word, we could explain some demographic variations by airport impact factors. For example, the annual passenger number of an airport has a direct impact on increasing population density, as well as decreasing the percentage of population ratio in its surrounding region. In other words, in an overall view, the higher the airport annual passenger number, the more attractions the airport

will bring to its airport region, thus to promote the population density and decrease the percentage of population aging by attracting young families to home in the airport region.

Therefore, in the dissertation, the author takes airport impacts (e.g. annual airport passenger, annual airport cargo tonnage) as causes, and demographic changes of airport regions (e.g. population density, percentage of population ratio, unemployment ratio etc.) as consequences , and attempted to build causality models to explain the correlations between every airport impact and it's resulting on demographic variations in airport regions. By doing this, local authorities or city planners would understand more systematically of: by what influence factor the airport will work on demographic variations of airport regions; how the demographic status will be transformed under airport impacts.

Moreover, quantification of airport impacts on demographic variation of airport regions is also one purpose of the study. By introducing the linear regression methodology, the author took statistic data of airport impact factors in selected European case study airports (the number of annual passenger, staff, cargo tonnages etc.) as explanatory variables, and took statistic data of demographic structure of corresponding airport regions (population density, aging structure, employment to population ratio etc.) as dependent variable, thus to find out established regression models to explain the quantification of different airport impact factors and their impacts on demographic variations in airport regions. By these established regression models, when facing challenges of urban development nearby a new international airport, it is possible to predict the volume ranges of demographic variations by known airport impact factors such as airport capacities, thus to control the development intensity at practical level.

- **To Investigate on Correlation and Quantification of Airport Impact on Land Use Distribution of Airport Regions**

Base on the case study of European airport regions, several purposes of the dissertation have been raised, which focus on airport impacts on land use distribution of airport regions. They are as follows:

- *To Investigate on the Impact of Distance to Airport on Land Use Distribution*

In Dr. John Kasarda's theory, large international airports should be considered as a new development core, which attracts urban development of all kinds and forms the aerotropolis with full city functions at vicinity. However, after a preliminary study the author found, for each different land use, the distance to airport is an influence factor that determines the location of their clusters and the tendency of their distributions surrounding the airport. For

example, the commercial land use (retail, supermarkets, hotels, etc.) are highly clusters at the range of 6 km distance to the airport, and start to sharply decrease from 6 km distance to the airport to airport exterior. Therefore, the research purpose has been raised to provide a perspective of land use distribution tendencies impact by the distances to airport. It goes a step further than Kasarda's aerotropolis prototype, and more precisely explain the land use distribution features of airport regions.

- *To Investigate on the Correlations between Airport Capacity Impact on the Total Volume of each Land Use Distribution in Airport Region*

In the dissertation, the author takes airport capacity (e.g. annual airport passenger, annual airport cargo tonnage, airport staff number) as causes, and the volume of different land use distribution (commercial, industrial, residential, research and higher educational etc.) as consequences, and attempted to build causality models to explain the correlations between airport capacity impact and it's resulting on land use distribution in airport regions.

Moreover, quantification of airport capacity impacts on the volume of each land use of airport regions is also one purpose of the study. By introducing the linear regression methodology, the author took statistic data of airport impact factors in selected European case study airports (the number of annual passenger, staff, cargo tonnages etc.) as explanatory variables, and took statistic volumes of each land use in selected airport regions as dependent variable, thus to find out established regression models to explain the quantification of different airport impact factors and their impacts on the volume of land use in airport regions. By these established regression models, it is possible to predict the volume ranges of each land use in airport region by known airport capacities, thus to control the development intensity at practical level.

- **To Investigate on Airport Location Impact on Land Use Distribution**

The location of an airport, in other word, the spatial relationship of an airport and its connected city also determines the geographical land use distribution of an airport region. The land use distribution features of an airport region shown different spatial features when the airport, as the development core, locates in metropolitan region (circle of cities), at city edge or is distant to the connected city. One purpose of the dissertation is, by introducing GIS density analysis, take selected European airport as case studies, to investigate on the land use distribution features of these three typologies. As well the study will includes the study of impact factors such as the city, airport, airport noise contour, ground traffic connections and their influence on the land use distribution of airport regions.

- **Hotspot Analysis of Land Use Distribution Features in Airport Regions**

The above purposes take airport region as a whole, and mainly discuss the scale, formation and prediction of the total volume of each land use of airport regions in an overall view. However, by study of resultants of hotspot analysis of eight selected European airport regions, the purpose of the study also includes investigation on land use distribution features inside the fence, in order to find out the specific distribution features of each land uses inside the airport region, as well to analysis the influence factors and their impact on each land uses development more preciously. By doing this, this dissertation will not only provide a perspective of the scale, formation and predictions of future land use development of airport region in an overall view, but also provide land use more detailed distribution principles inside the airport regions.

- **Investigation on Reinterpretation of the Urban Image of European Airport Regions**

As have stated in background studies, airport regions are under most direct airport impacts and has numerous uncertainties concerning its future development. Airport impacts, especially airport noise impact are also the main reason of social protests airport and airport region development. A positive urban image, combine with strategies and technologies that promoting living quality of communities in airport region may maximally decrease the social protest, thus provide a better living condition for local residents, as well maximally decrease the social protest from local society. Meanwhile, proper urban branding implementations at the beginning of the development of the airport region may also larges promote local competitiveness of the airport region.

Therefore, in the dissertation the author also intends to find out: What is the proper urban image of an airport region? How to integrate diverse solutions into urban image strategies, thus to satisfy the interests of all parties? How to implement the urban image strategies at the beginning of the airport region development?

- **To Investigate on Integrated Urban Development Strategies for the BER Airport Region**

As the context of the previous study, the purpose of the study also includes the investigation on implementation of previous research outcomes in the new Berlin-Brandenburg Airport (BER) Region. The selected statistical data of BER airport capacity, demographic and land use distribution status of airport region and the wilder range will be substitute into established linear regression models, to predict the volume of each land use distribution and

the volume of demographic variation in the new BER airport, thus to provide a clarified precondition for planners and decision makers to better control the development intensity of the BER airport region.

The study will also base on the statistic data of existing land use and demographic status of the future BER airport region, by introducing the previous hotspot analysis and density analysis research resultants, to find out the future land use clusters of the BER airport region, as well as provide suggestions for adjusting the existing BER airport regional plan.

The dissertation also includes a general study of current research programs and pilot projects which focus on airport region development, as a brief documentary of current research projects.

1.3 **Research Scope**

As the test fields of this dissertation are communities in the airport region of the new Berlin Brandenburg International Airport (BER), in order to obtain case studies showing most similarities to the BER airport, the principles for their selection were: Case study airports should be in Europe; case study airports should be large primary hub airports and belong to the same subcategory as the BER airport; case study airports should have both general aviation and air cargo services; selected airports should be located in mega cities or at the edge of a mega city.

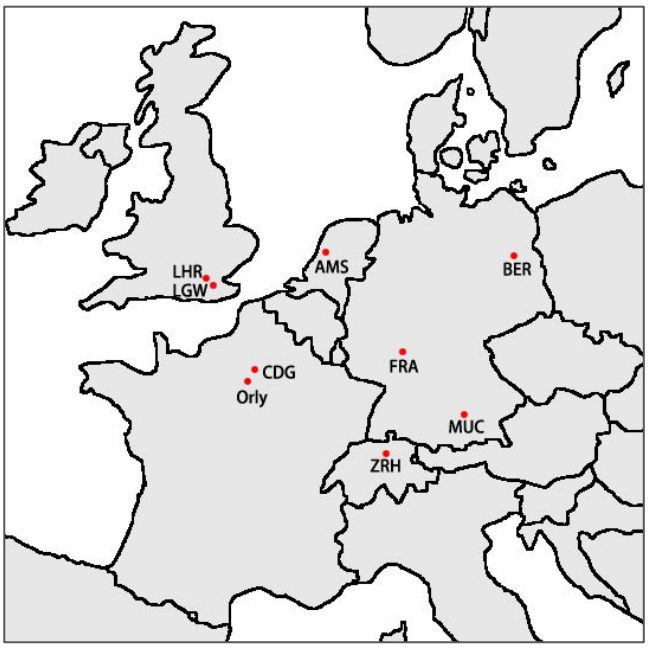


Figure 1-5 Selected Case Study Airports of this Thesis
Source: by the author

According to these principles, eight large hub airports in six European metropolises were selected. They are: London Heathrow Airport; London Gatwick Airport; Paris Charles de Gaulle Airport; Paris Orly Airport; Amsterdam Schiphol Airport; Frankfurt Airport; Munich Airport; Zurich Airport.

Obviously, the status of the regions around the selected case study airports is under impact of different influencing factors, like capacity of the airports, status of the airports host

cities, etc. Communities surrounding different airports show distinct features, and the scale of these "directly impacted" airport regions also vary. In order to investigate common features of case study airport regions on a similar basis, it is necessary to define the range of these airport regions. There are several factors in considering the scale of the airport regions of the case study airports. First is the average area of each airport region; second is the density of the airport-linked ground traffic network; and third is the direct impact range of these selected airports (airport cities). In considering these influencing factors, communities were selected in a circle, with the airport at its center and a 15-km radius (travel time within 30 minutes), for further study.

1.4 **Approaches**

In order to achieve a more rational and objective research result, this investigation is based on analysis of a large number of statistical data from selected case study airports, their surrounding communities and host cities. Therefore, the dissertation not only includes study literature, but also introduces GIS analysis, linear algebra and statistical approaches in the data assessment.

- **GIS (Geographical Information System) and ArcGIS system**

A geographic information system (GIS) is a technique used to describe and characterize the earth and other geographies, for visualizing and analyzing geographically referenced information.

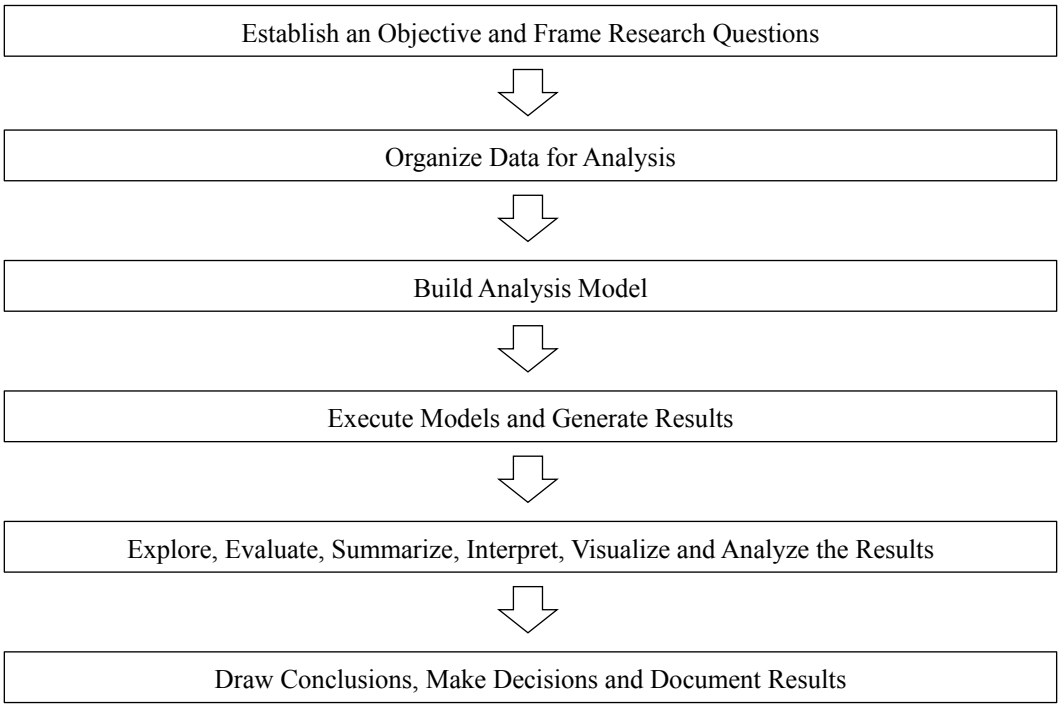
Many have characterized GIS as one of the most powerful of all information technologies because it focuses on integrating knowledge from multiple sources (for example, as layers within a map) and creates a crosscutting environment for collaboration. In addition, GIS is attractive to most people who encounter it because it is both intuitive and cognitive. It combines a powerful visualization environment – using maps to communicate and visualize – with a strong analytic and modeling framework that is rooted in the science of geography[25]. There are several advantages to GIS, such as cost savings and increased efficiency, decision making, improved communication, and better record keeping.

ArcGIS is a comprehensive system that allows people to collect, organize, manage, analyze, communicate, and distribute geographical information. As the world's leading platform for

[25] *What is GIS*, ArcGIS 10 Help, Esri, www.Esri.com

building and using geographical information systems (GIS), ArcGIS is used by people all over the world to put geographic knowledge to work in government, business, science, education, and media[26].

In the present dissertation, spatial analyses based on the GIS platform mainly include: Cluster and Dispersion analysis for investigating land use features; neighborhood statistics to analyze spatial correlations; center feature analysis for locating new development hot spots; standard distance tool for assessing the spatial patterns of neighborhoods within communities; weight overlay analysis for weighting land use analysis of BER-surrounding communities; and Spatial Autocorrelation tool for predicting further development trends.



■ Linear Regression

Linear regression models are used here for taking into account the effects of other variables. Regression analyses are applied for data description, prediction, parameters estimation and control[27]. Regression analyses are mainly employed to predict dependent values by those of one or more independent variables. In studying the linear relationship between two or

[26] *Introduction to ArcGIS*, Esri. www. Esri.com

[27] Douglas C. Montgomery, Elizabeth A. Peck, and G. Geoffrey Vining, *Introduction to Linear Regression Analysis, 4th Edition Student Solutions Manual*, 4 edition (Hoboken, N.J.; Chichester: Wiley-Interscience, 2007).

more variables, linear regression is used as the widest model[28]. The most representative model under use in simple linear regression is:

$$y_i = \beta_0 + \beta_1 x_1 + \beta_2 x_2 \ldots\ldots + \varepsilon$$

Suppose we reckon that some variable of interest *y* is "driven by" some other variable *x*. We then call *y* the dependent variable, and *x* the independent one. In addition, suppose that the relationship between *y* and *x* is basically linear, but inexact: besides its determination by *x*, *y* has a random component ε, which we call the "disturbance" or "error". The parameters β_0 and β_1 represent the y-intercept and the slope of the relationship[29].

In order to estimate the unknown parameter of β_0 and β_1, a number of samples of *x* and *y* should be gathered, and the equation will have the form:

$$\hat{y}_i = \hat{\beta}_0 + \hat{\beta}_1 x_i$$

Then, ε is defined with each pair of data as the actual y_i value minus the $\hat{y}_i$, which is predicted based on x_i along with the estimated coefficients:

$$\hat{\varepsilon} = y_i - \hat{y}_i = y_i - \left(\hat{\beta}_0 + \hat{\beta}_1 x_i\right)$$

In a scatter plot of y and x, the ε is the vertical distance between y_i and $\hat{y}_i$, as shown in Figure1-8, and $\hat{\varepsilon}$ is the minimal distance between y_i and $\hat{y}_i$. The oblique line represents the linear correlation between *x* and *y*.

Simple linear regression is used for three main purposes:

1. Describe the linear dependence of one variable on another;
2. Predict values of one variable from values of another, for which more data are available;
3. Correct the linear dependence of one on another, to clarify other features of its variability.

In statistics, ordinary least squares (OLS) is a method for estimating the unknown parameters $\hat{\beta}_0$ and $\hat{\beta}_1$ in a linear regression model, and minimizes the sum of squared vertical distances between the observed responses in the dataset and the responses predicted by the linear approximation. There is no guarantee that the "best fitting" line fits

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[28] Clemens Reimann et al., *Statistical Data Analysis Explained: Applied Environmental Statistics with R* (Chichester, England ; Hoboken, NJ: Wiley, 2008), 53.

[29] Allin Cottrell, *Regression Analysis: Basic Concepts*, Wake Forest University. accessed Sep 2012, http://users.wfu.edu/cottrell/ecn215/

the data well: maybe the data do not even approximately lie along a straight line relationship, so that we then need to use OLS to "check" if the result is "best fitting".

Commonly, what gives a measure of the "goodness of fit" of the estimated equation is R^2 (known as the coefficient of determination). This calculation is done as follows:

$$R^2 = 1 - \frac{\sum(y_i - \hat{y}_i)^2}{\sum(y_i - \bar{y}_i)^2} = 1 - \frac{SSR}{SST}$$

SSR is considered as the unexpected variation in the dependent variable – the variation "left over" in the prediction of the regression equation is taken into account. The expression of SST, on the other hand, represents the total variation of the dependent variable around its mean value. So, R^2 can be written as 1 minus the proportion of the variation in y_i that is unexplained; in other words, it shows the proportion of the variation in y_i accounted for by the estimated equation. As such, it must be bounded by 0 and 1:

$$0 \leqslant R^2 \leqslant 1$$

If $R^2=1$, the estimation is a good score, obtained only if the data points happen to lie exactly along a straight line; $R^2=0$ is thus a bad score, indicating that x_i is absolutely useless as a predictor for y_i.

In this dissertation, linear regression models are mainly applied for analyzing data from existing airports and their surrounding communities, and statistics of GIS for analyzing results to summarize common features and tendencies of airport impacts on the development of neighboring communities.

1.5 **Structure of the Dissertation**

The dissertation is divided into six main Chapters as follows:

- The first chapter states the background, the purposes and specific questions, the scope, the structure of the dissertation, as well as approaches of the study;

- The second chapter is the study of airport impacts on demographic variations in airport regions. In this chapter, GIS density analyses have been made to define the scope of airports impact on demographic variation; linear least squares methodologies have been used to find out the correlations between the airport capacity impact and the demographic variation; Established linear square models have been found out for predictions of airport impact on demographic variations in new airport regions;

- The third chapter is the study of airport impacts on land use variations in airport regions. This chapter includes the literature review of airport impact on land use distribution and land use formation; GIS density analyses of the distribution tendency and the concentrated ranges of each land use by distances to the airport; Using linear least square methodologies to found out the correlations between airport capacity impacts and the volume of each land use in airport region; the study of airport geographic location impacts on land use distribution; a study of ground traffic and airport noise impact on land use distribution as well as a hotspot analysis of land use distribution inside fence of airport region.

- The fourth chapter is the study of how to integrate solutions from diverse fields within urban image approaches, thus for a concordant urban development at the beginning of a new airport region development. This chapter includes a brief literature study of urban image theory, urban branding, and its significant in the knowledge economy era; a study of appropriate urban image in airport region; and the study of possible implementation approaches for airport region development.

- The fifth chapter is the study of Integrated Urban Development Strategies for the BER Airport Region. In this chapter, the status of BER airport, ground traffic connection, demographic and land use status of BER airport region; The implementation of established linear regression models in BER airport region has been studied, thus to predict the future value variations of demographic and land use in BER airport region; The urban development purpose of the BER airport region has been evaluated; The existing research programs and pilot projects in establishing the BER airport region have been summarized.

- The sixth chapter is a brief documentation of Research Programs and Pilot Projects in the Establishing Airport Region.

- The seventh chapter is the conclusion of the dissertation. It includes the conclusive summary of the contents of the dissertation; the perspective of urban development in the BER surroundings as well further research questions.

2 Community of Vitality – Focus on Demographics

In the planning concept, there are three important elements in composing the social structure of a region. They are: population density, proportion of elderly people (population of 65 years or older compared with the total population), and unemployment ratio. These three elements reflect not only social security and urban activity performance a sociological level, but also the economic status and development potential. Moreover, acknowledgement of these three points is also important for understanding the status of the social structure on site, which is a significant phase for further urban design and urban planning researches.

2.1 The Significance of Social Structure Effects on Urbanization

■ Population Density as Determinant of Urbanism and Economic Development

Population density is an important determinant in testing economic or urbanization growth. According to Simon and Gobin[30], the more the people, the better the economic performance. Avent[31] also indicated that, when the moment for economic growth and the creation of jobs comes, for a city, the denser, the better. Economists studying cities routinely verify that, after controlling for other variables, workers in denser places earn higher wages and are more productive. In addition, a worker hoping to make a living will have a much easier time in a larger city, a the labor turnover may be greater (more job opportunities provided by more working places), and the odds of finding employment are higher. This security function is important because it reduces the risks associated with specialization, and therefore encourages more of it. By allowing workers to focus on tasks at which they are relatively better than others, specialization helps drive economic growth, and also constitutes an engine of innovation[32]. Thus, dense cities, by serving as sources of security, enable workers with good ideas to take risks and start new businesses.

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[30] Julian Lincoln Simon, Roy Tyrone Kaimlall Gobin, and University of Illinois at Urbana-Champaign. College of Commerce and Business Administration, *The Relationship between Population and Economic Growth in LDC's* ([Urbana, Ill.] : College of Commerce and Business Administration, University of Illinois at Urbana-Champaign, 1979), 41

[31] Ryan Avent, "One Path to Better Jobs: More Density in Cities," *The New York Times*, September 3, 2011, sec. Opinion / Sunday Review, http://www.nytimes.com/2011/09/04/opinion/sunday/one-path-to-better-jobs-more-density-in-cities.html.

[32] Ryan Avent, "One Path to Better Jobs: More Density in Cities," *The New York Times*, September 3, 2011, sec. Opinion / Sunday Review, http://www.nytimes.com/2011/09/04/opinion/sunday/one-path-to-better-jobs-more-density-in-cities.html.

During the Industrial Revolution, millions of workers fled into fast-growing cities, especially in EU countries. Therefore, there are small chances nowadays for revitalization in rural areas and small towns which took agriculture as their pillar industry. A vicious circle begins in which the lower the population density, the less attractive it becomes to retain young people, as well as for industries and business to settle in them. Therefore, whether an airport could raise the local population density by retaining young people and attracting new residents is an important determinant to evaluate the local economic status and urban vitality.

- **Proportion of Elderly People as Determinant of Economic Development and Urbanism**

The aging population ratio is also an important determining factor in predicting economic activity and development potential. The European baby boom happened in 1950s. This means that the proportion of retired people relative to the working population will increase sharply in the next few decades. In fact, the high elderly ratio already happens in most European cities, especially in cities or towns which lack pillar industries. According to World Bank statistics[33], in less than forty years more than one-third of Europe's population will be above the age of 60, and one-fourth will be older than 65. This ongoing shift in demographics will have widespread repercussions across whole Europe, but will be particularly difficult for EU11 countries. Aggregate labor force participation rates in those countries already lags behind Europe as a whole, and drastic decline in the size of the labor force is expected to occur over the next forty years, further hampering economies in this region.

The rising aging population ratio is also a barrier for economic development in Germany. According to statistics by Robert Ayres[34], the number of workers supporting each retired German citizen today, via the main government "pay-as-you-go" (PAYG) system, is about three. By 2030, if current trends continue, the number of active workers per retired citizen will be only 1.5. At that time, costs of the government for the net of retired citizens will be of at least 25% of the GDP for industrialized countries. Therefore, a large number of German small to mid-sized cities and towns are facing problems like the shortage of young people, or lack of attractiveness to retain young families, which is a chain reaction that

[33] The EU 11 in an Aging Europe, The World Bank News, accessed Sept. 2012, http://www.worldbank.org/en/news/feature/2013/01/17/the-eu-11-in-an-aging-europe

[34] Robert Ayres, The Economic Conundrum of an aging population, World Watch, September/October 2004

causes a loss of competitiveness.

- **Employment-to-Population Rate as Determinant of Economic Development and Urbanism**

Employment-to-population ratio is a statistical measure which indicates the proportion of total working-age population (ages 15-64 in most OECD countries) that is employed. It is composed by two numbers: the total working-age population and civilian employment. It measures the percentage of the adult population that has a job. In other words, it indicates which proportion of the working-age population is employed[35].

Compared with the unemployment rate, which is the best-known parameter for measuring labor market conditions, the employment-to-population ratio provides certain insights into the labor force not included in the unemployment rate. To count as unemployed, a person must be without a job, be available for work and have actively sought a job sometime during the month, or must be on layoff expecting to be recalled. To be counted as employed, a person must have worked at least one hour during the week for pay or profit. In other words, being employed is an observable experience, while being unemployed often lacks some concreteness. According to Geoffrey Moore[36], seeking a job is not as clear-cut a condition as having a job…… For a sizable number of the jobless, whether one is unemployed or not is to some degree a matter of opinion. Hence, the employment-to-population ratio has the advantage of measuring something which is quite observable. Carol Leon indicated "This statistic measures the economy's ability to provide jobs for a growing population; its consistent cyclical properties and the relative accuracy of its seasonal adjustment make the ratio especially useful for evaluating demographic employment trends"[37] This way, the employment ratio tells whether the economy is generating jobs fast enough to provide employment for a constant proportion of the population. In other words, by relating employment to population, we can evaluate the magnitude of job growth.

Population density, aging population ratio and employment-to-population ratio are prominent determinants of the social structure. Therefore, knowing whether these current

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[35] Carol Boyd Leon, "Employment-Population Ratio: Its Value in Labor Force Analysis, The," *Monthly Lab. Rev.* 104 (1981): 6.

[36] Carol Boyd Leon, "Employment-Population Ratio: Its Value in Labor Force Analysis, The," *Monthly Lab. Rev.* 104 (1981): 10.

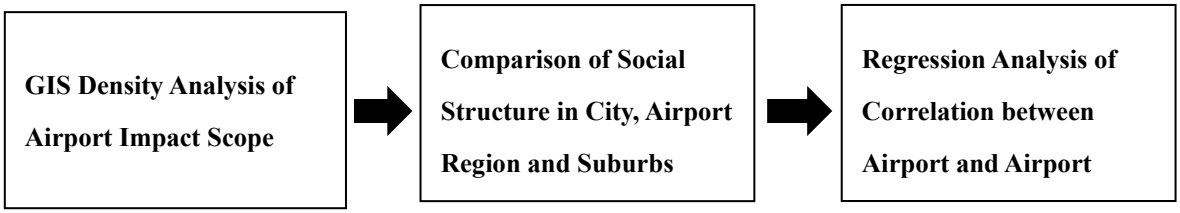
[37] Carol Boyd Leon, "Employment-Population Ratio: Its Value in Labor Force Analysis, The," *Monthly Lab. Rev.* 104 (1981): 1.

problems could be reversed or solved is important in judging the contribution of the urban element to its connect city and urban region's economic activities, as well as in inhibiting population shrinking, decreasing the aging population ratio, and reducing the unemployment ratio.

Since the airport city model became the tendency of international airport development, the role of an international airport has not been simply considered as traffic infrastructure, but also as a new development engine. Along these lines, the following chapter consists of GIS analyses of eight selected case study airports and their connected urban regions, as a means to investigate how and to what extent an international airport contributes with the social constitution by providing more job opportunities, increasing the population density and decreasing the aging population ratio, as well as in reducing the unemployment ratio. For local authorities and practical city planners, these could be considered important preconditions for making development plans of an airport region.

The GIS analyses in this chapter include eight chosen case studies of international airports of four European metropolises. These are: the Heathrow and Gatwick airports in London, England; Charles de Gaulle and Orly airports in Paris, France; Munich Airport and Frankfurt Airport in Germany; Zurich Airport in Switzerland; and Amsterdam Schiphol airport in the Netherlands. All of these are among the top-20 busiest airports in Europe according to passenger number in 2012 (with Heathrow ranking 1st, Gatwick ranking 10th, Charles de Gaulle ranking 2nd, Orly ranking 12th, Munich ranking 7th, Frankfurt ranking 3rd, Schiphol ranking 4th, and Zurich ranking 15th).

The approaches in studying airport impacts on surrounding communities by raising their population ratio, decreasing the proportion of elderly people and raising the employment ratio follows three steps:



2.2 GIS Analysis in Defining Airport Impact Area

The GIS density analysis is the first step to evaluate airport impacts on social changes in nearby communities. The research scope consists of each case study airport, its connected

city and a range of urban regions around the airport-related city. After collection of pertaining statistical data and administration of the information, the second step was to enter the necessary statistical data, obtained from authorities of each airport-connected city, such as population, area, employed population (in 15-64-year-old range), aging population (65 years old and older), etc., into a platform of the GIS data map. The third step was to color graduates this geo-information into GIS maps about population density, proportion of elderly people and employment-to-population ratio of each administrative division of the case study cities.

The color-graduated GIS maps provide intuitive results on density distribution in each case-study airport city and surrounding region. From these density distribution maps it is possible to investigate on the scope of the case study airport impacts its surrounding urban region, as well as the intensity of the airport will impact its surrounding communities. Moreover, based on these maps it is also possible to summarize common points of population density distribution, aging population distribution and job market distribution, though the most important is to define the airport impact regions for further analyses.

Several common density distribution features could be seen from outcomes of GIS analyses of all eight case study airports in six cities as to population density, elderly ratio and employment-to-population ratio. London could be a good example to explain these features.

- **Populous/Low-Senior Generation Ratio Hot Spots Around Airports**

GIS analysis outcomes for population density and aging population ratio shows that communities near airports have obviously higher population density and lower aging population ratio than other communities in suburbs of the airport-connected cities. This indicates that communities in the airport region are more attractive for young families, owing to more job opportunities provided by the airport and its related industries.

Let us take London as an example. The mean population density of London city (communities inside the city boundary circle of Figure 2-1 and Figure 2-2) is about 5,122 people per square kilometer (km^2), and the aging population density is 11.0%. The average population of London suburbs and surrounding towns and villages is about 181 inhabitants per km^2, and the average aging population ratio is about 30%. However, the borough of Slough near Heathrow airport (point B on Figure 2-1 and Figure 2-2) has a population density of 1,671 people per km^2 and an aging population ratio of 9%; in turn, the borough of Gatwick has a population density of 935 people per km^2 and an aging population ratio of 12%. This means that Slough's population density is nine times higher than the average level of other boroughs in the London suburb ring, and Slough's aging population density is about three times lower than the average level of London suburbs. Further, Gatwick's population density is five times higher than the average level of the London suburb ring, and the aging population density is about 2.5 times lower.

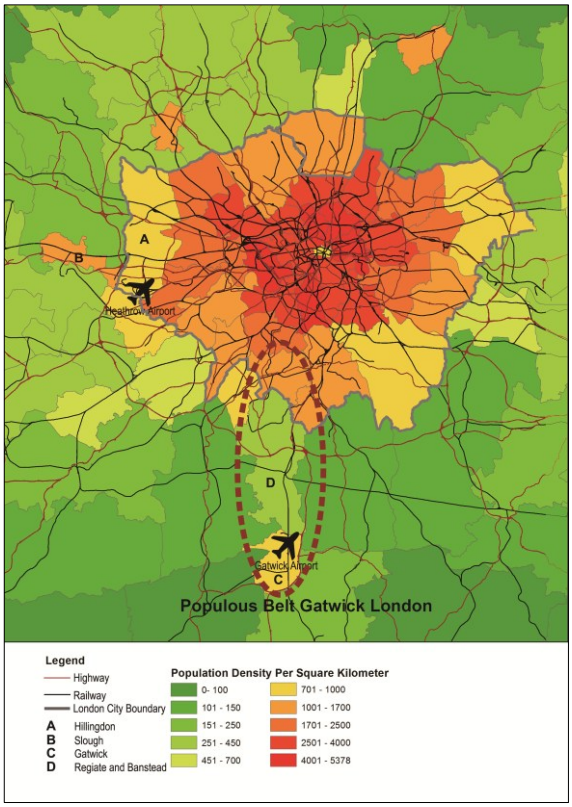


Figure 2-1 London Gatwick Populous Belt
Source: By the author according to data provided by the Office for National Statistics UK 2011

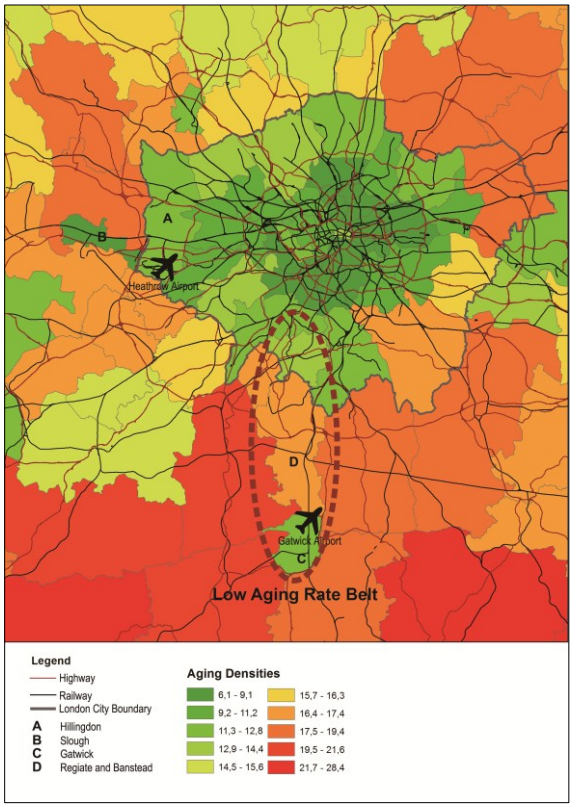


Figure 2-2 London-Gatwick Low Aging Belt
Source: By the author according to data provided by the Office for National Statistics UK 2011

However, statistics also show that the sharply high population density did not appear in all communities in airport regions. Taking London Heathrow as an example, only the borough of Slough has extremely high population density and low aging population ratio in the Heathrow airport region. This indicates that, although airports attract a large number of

young families and solve unemployment problems of its surrounding communities, these new inhabitants are not equally distributed in all communities of an airport region. Therefore, for community authorities in an airport region, a comprehensive land use policy, sufficient social service facilities as for education, healthcare, real estate market, etc., will promote competitiveness in attracting young families to the airport region.

- **Traffic Corridor as New Populous/Low Senior Generation Ratio Belt**

GIS analysis of population distribution and aging population ratio also reveals that populous belts are formed between the airport and its connected city along traffic corridors, especially in the case study airports, which have certain distance to their connected main cities. From these eight case study airports, communities along London Gatwick (47.5 km to downtown London) and Munich Airport (27 km to Munich city center) have formed more obvious development belts along corridors between city and airport than in the other cases.

The GIS density analysis also shows that, although communities along both railway as well as highway connecting the airport to the city have a higher population density and lower proportion of elderly people, the railway network has more significant impacts than the highway, i.e., communities along railways have higher population density and lower aging population density than those along highways. This occurs assumedly because public transportation like railways or subways is more convenient for commuters traveling from/to their workplace and also more serviceable to transport airport passengers.

Taking London again as an example, the borough of Reigate and Banstead has a population density of 418 people per km^2, and an aging population ratio of 16%. Compared to the average London suburbs level, its population density is 2.3 times higher, and its aging population ratio is about two times lower. Moreover, according to statistics of the borough council, with Gatwick airport on their doorstep, excellent access to London Heathrow and express train connections to London and the south coast, the borough has attracted many major international companies, already based in it, like Canon, Kimberly-Clark, AXA insurance, etc.

2.3 Comparison Study of Airport Impacts on Social Structure

The aim of the present study was to investigate the extent of an airport's influence in promoting population density, decreasing the fraction of the senior generation, and balancing the employment rate in airport impact zones by comparison with the urban region

and city suburbs. The study composed by three types of objects, the urban region, the airport direct impact zone, and suburbs of the airport-connected city.

For London, the urban region is specified as the city of London; the airport region is defined as the borough of Slough, Hillingdon and South Bucks near the Heathrow airport, and the borough of Crawley, Reigate and Banstead near Gatwick; and the surrounding territory of London comprises Essex, Kent, Surrey and other eight administrative counties around the city of London. Statistical data are from the census 2011 of the Office for National Statistics UK (ONS).

For Paris, Paris city and three departments from the inner ring of Ile-De-France represent the urban region; four departments of the outer ring of Ile-De-France constitute the suburban region. The airport impact region consists of 96 communes around the two airports. Statistical data are from the census 2011 of the National Institute of Statistics (INSEE).

For Munich, the city region comprised the city of Munich, and the surrounding region consisted of 15 Landkreise (administrative districts) around Munich city. The airport impact region was considered as nine Gemeinden (communities) surrounding the airport or along the airport-city corridor. For the Frankfurt Airport, the encircling urban region comprised six Landkreise around Frankfurt city. The airport-surrounding region is considered as seven Gemeinden around the airport. Statistical data are from the census 2011 of the Federal Employment Agency (Bundesagentur für Arbeit).

For Zurich, the urban area is considered as the city of Zurich. The surrounding region consists of the Canton of Zurich. The airport impact region comprises 11 Gemeinden surrounding the airport or along the airport-city corridor. Statistical data are from the census 2011 of the Swiss Statistics.

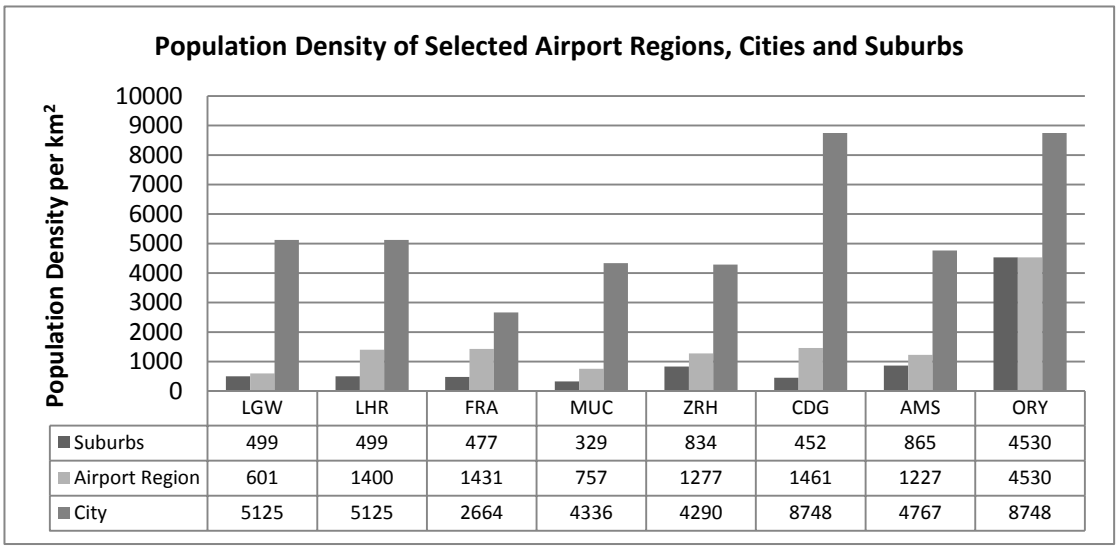
For Amsterdam, the urban region is considered as the city of Amsterdam. The surrounding region is defined as 12 communities encircling the city of Amsterdam. The airport region is defined as 4 communities adjacent to the airport. Statistical data are from the census 2011 of Statistic Netherlands (CBS).

The chosen scopes of the study and of these three types of research objects are as shown in the following chart.

	Object	Population Density (People/ km^2)	Elderly Ratio (%)	Employment Ratio (%)	Map
London	City (A)	5125	11.3	65.6	
	Outskirts (B)	499	16.73	75.7	
	Heathrow Region(C)	1400	11.2	74.5	
	Gatwick Region (D)	601	15.24	78.3	
Paris	City(A)	8748	16.6	66.6	
	Outsikrts(B)	452	11.87	67.6	
	CDG Region (C)	1461	10.12	62.8	
	Orly Region (D)	4530	12.74	67.2	
Munich	City (A)	4336	17.9	95.78	
	Outskirts (B)	329	19	98.74	
	Airport Region (C)	757	15.8	98. 76	
Frankfurt	City (A)	2664	16.6	93.97	
	Outskirts (B)	477	20.2	95.7	
	Airport Region (C)	1431	17.2	96.68	
Zurich	City (A)	4290	16.6	79.8	
	Outskirts (B)	834	16.4	81.9	
	Airport Region (C)	1277	14.9	83.8	
Amsterdam	City (A)	4767	11.3	74.0	
	Outskirts (B)	865	16.9	81.5	
	Airport Region (C)	1227	14.4	83.1	

Table 2-1 Scope and Statistical Data on City, Airport Region and Outskirts of Case Study Airports

Source: By the author according to census data 2011



	LGW	LHR	FRA	MUC	ZRH	CDG	AMS	ORY
Suburbs	499	499	477	329	834	452	865	4530
Airport Region	601	1400	1431	757	1277	1461	1227	4530
City	5125	5125	2664	4336	4290	8748	4767	8748

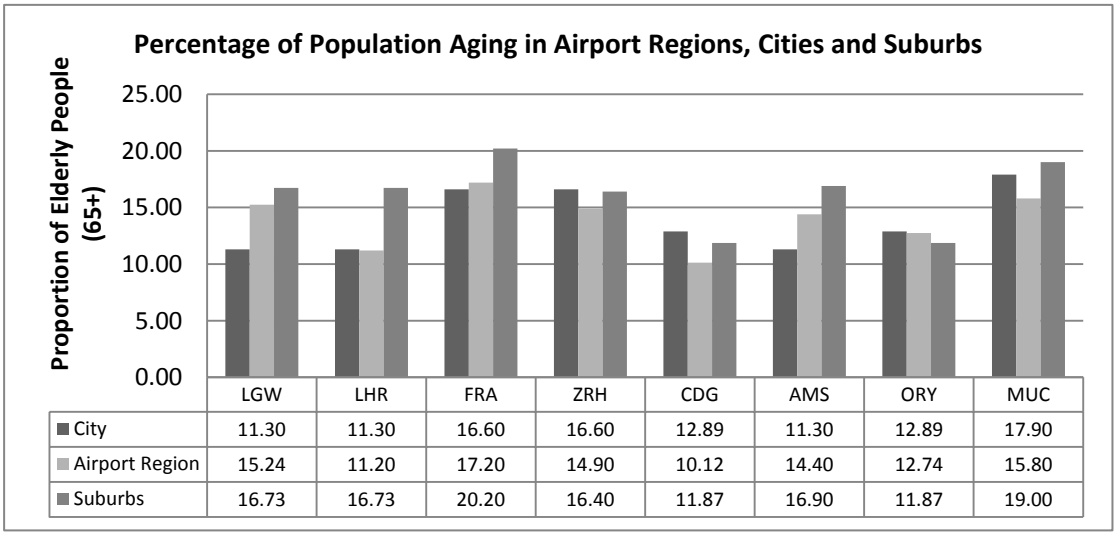
Figure 2-3 Average Population Density of Case Study Airports, Suburbs and Urban Regions
Source: By the author according to Statistical Data 2011

Figure 2-3 shows the population density in case study airport regions, suburbs and airport-related cities of each case study airport in 2010. It clearly shows that the airport, as an urban development motor, could as well highly promote the population density of its periphery. Except for Paris Orly, all case study airports are located in suburban regions, and the population density of each case study region is much higher than the mean population density of other suburban regions. Regarding the Munich airport region as an example, the population density corresponds to 757 people per km^2, and the mean population density of Munich suburban area is 329 people per km^2; thus, the population density of the Munich airport region is about 2.3 times higher than ordinary suburban regions.

Furthermore, the above figure also indicates a tendency that population density in an airport region is proportional to the airport capacity: The higher the airport capacity, the higher the population density of the airport region. This tendency is more obviously seen in London Heathrow and London Gatwick airports. The annual passenger number of London Heathrow is 69.4 million, which is more than two times higher than the annual passenger number of London Gatwick airport (33.7 million in 2011), and the population density in the Heathrow airport region is of about 1,400 people per km^2, which is also more than twice the population density in the London Gatwick airport region (601 people per km^2 in 2011). Therefore, an assumption is raised that the annual airport passenger number may have a correlation with the population density in the respective airport region.

More young families settling in an urban region will bring purchasing power, available labor force and urban vitality. It is a significant precondition for urban revitalization, since the aging society is also an evident problem hindering the further urbanization in most

European cities.

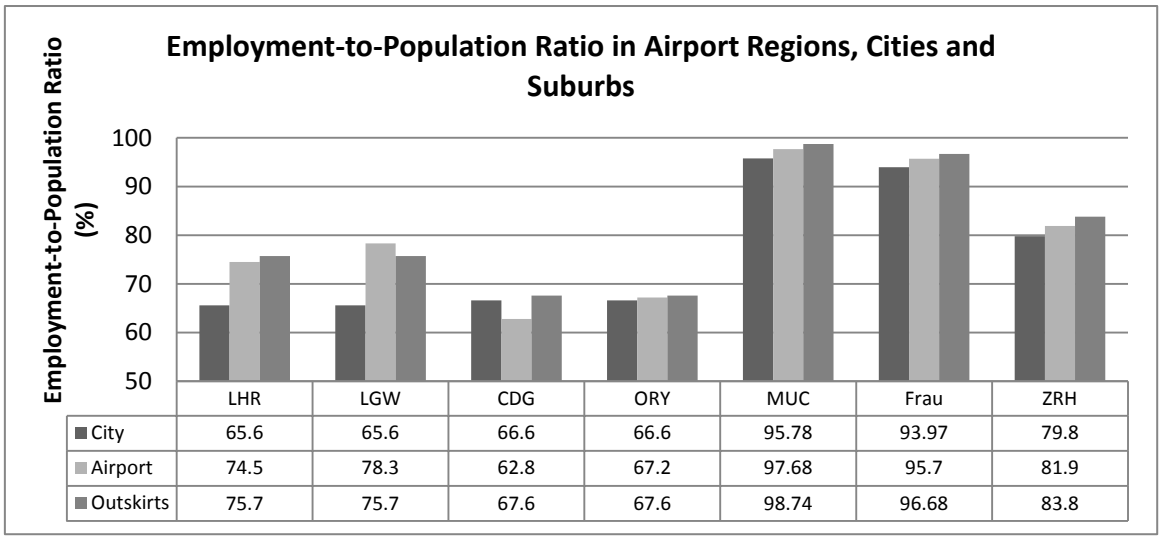


	LGW	LHR	FRA	ZRH	CDG	AMS	ORY	MUC
City	11.30	11.30	16.60	16.60	12.89	11.30	12.89	17.90
Airport Region	15.24	11.20	17.20	14.90	10.12	14.40	12.74	15.80
Suburbs	16.73	16.73	20.20	16.40	11.87	16.90	11.87	19.00

Figure 2-4 Proportion of Elderly People of Case Study Airports, Suburbs and Urban Regions
Source: By the author according to Statistical Data 2011

Figure 2-4 shows the percentage of aging population (65+) in selected case study airport regions, airport-connected cities and suburban regions. It indicates that airports have strong influence on decreasing population age in their periphery. Except for Paris Orly, all case study airport regions are located in suburban regions. However, the percentage of aging population in these areas is not only lower than the mean percentages of aging population in suburbs, but in some case is even lower than in their connected cities. For example, the percentage of aging inhabitants in the London Heathrow airport region is 11.20%; in the suburbs of London it is 16.73%, and in London city 11.30%. Therefore, the percentage of aging population in the Heathrow airport region is not only 5.53% lower than in London suburbs, but even 0.1% lower than in London city itself.

Furthermore, the above figure also indicates a tendency that the proportion of elderly people in the airport region is inversely proportional to the airport capacity: The higher the airport capacity, the lower the proportion of elderly people in the airport region. This tendency is more obvious in London Heathrow and London Gatwick airports. The annual passenger number of London Heathrow Airport is 69.4 million, which is more than two times higher than the annual passenger number of London Gatwick (33.7 million in 2011); in turn, the proportion of elderly people in the Heathrow Airport region is about 11.2%, which is also obviously higher than Gatwick airport region (15.24% in 2011). Thus, an assumption is raised that the annual airport passenger number may have a negative correlation with the proportion of elderly people in the airport region.



	LHR	LGW	CDG	ORY	MUC	Frau	ZRH
City	65.6	65.6	66.6	66.6	95.78	93.97	79.8
Airport	74.5	78.3	62.8	67.2	97.68	95.7	81.9
Outskirts	75.7	75.7	67.6	67.6	98.74	96.68	83.8

Figure 2-5 Employment-to-Population Ratio of Case Study Airports and Connected Cities (%)
Source: By the author according to Statistical Data 2011

Figure 2-5 shows the percentage of employed people in the total working-age population (15-65) of each case study airport, city and outskirts. Comparing Figure 3-3 and Figure 3-5, we can conclude that the city population density is higher than in the outskirts (except for Paris), yet the employment-to-population ratio in cities is lower than in their outskirts. However, when a rapid urbanization occurs under impact of a strong effector, the urbanization itself will also be associated with a sharp rise in unemployment. Taking as example the first trend of industrial revolution and railway development in Victorian cities in England, "all these factors – population explosion, immigration both foreign and domestic – added up and resulted in a scramble for any job available. Large numbers of both skilled and unskilled people were looking for work, so wages were low, barely above the subsistence level"[38].

High unemployment rate is a main cause of social problems and slowing down economic development. "The personal and social costs of unemployment include severe financial hardship and poverty, debt, homelessness and housing stress, family tensions and breakdown, boredom, alienation, shame and stigma, increased social isolation, crime, erosion of confidence and self-esteem. Most of these increase with the duration of unemployment. Unemployed people report that being unemployed is one of the worst things that can happen to them."[39]

[38] "Hidden Lives Revealed: A Virtual Archive - Children in Care 1881-1981," Text, accessed September 27, 2014, http://www.hiddenlives.org.uk/articles/poverty.html.

[39] Alison McClelland and Fiona Macdonald, "The Social Consequences of Unemployment," *Report for the Business Council of Australia*, 1998, 5

Airport-based urbanization leads to a high increase in population density, but because this development mainly affects specific industries, most of which tertiary ones such as tourism, high-tech innovation or creative industry, it is unlike previous urbanization progress; urbanization based on airport impact has not been associated with high rise of unemployment rate as in cities. Figure 2-5 shows that the employment-to-population ratio in seven case study airports of five cities did not fluctuate in an obvious way. The employment-to-population ratios in all airport-surrounding regions are higher than in their its connected cities, on average about 3.2% higher than in the urban region.

2.4 Regression Analysis of Correlation between Airport Capacity and Social Structure in the Airport Region

By intuition, airport capacity (passenger flow) represents the size of an airport and is a main determinant of the development intensity in airport-surrounding communities. Obvious airport-directed economic development and urbanization appeared in all communities neighboring case study airports. Moreover, in a general view, the larger the airport capacity, the more significant the influence that the airport will have on surrounding communities.

In this case, each scalar dependent variable y designate the annual passenger flow of each case study airport, and explanatory variables denoted by x are considered as the possible social structure value of communities around each case study airport that may have linear relation with capacities of each of them. The significance level is 5%, as usual in regression analysis.

The aim of this study was: 1.) Trying to find a linear relationship between airport capacity and changes in social constitution in airport-surrounding localities; and 2.) attempting to find out the intensity degree (parameter ß) of airports on the social structure of airport-neighboring communities. The results of ß could be used for estimating how a newly opened European airport could impact population density, aging population ratio and employment-to-population ratio based on its intrinsic capacity. If the regression model is a linear distribution and the parameter ß is fixed, the linear model could become a significant reference for the BER-airport-surrounding communities to predict their social constitution, like changes in population density, aging population ratio and employment-to-population brought about by the new BER airport in the future.

■ Regression Analysis of Airport Capacity Impact on Population Density

Based on the above statistical data, linear regression models were employed in this paper to investigate the relationships between the airport passenger traffic and the variation in population density in the airport periphery. Because Paris Orly is not located in the suburbs as the other case study airports, data on this airport are considered as outliers in the regression analysis. The level of confidence is 95%, and the model is presented as follows:

Model 1 $y_a = \beta_c x_c + \beta_s x_s + \beta_a x_a + \varepsilon$

Model 2 $y_{a/c} = \beta_a x_a + \varepsilon$

Model 3 $y_{a/s} = \beta_a x_a + \varepsilon$

Where:

y_a — population density of airport region (people per km^2)

$y_{a/c}$ —quotient of airport region population density divided by city population density

$y_{a/s}$ —quotient of airport region population density divided by suburban population density

x_c — population density of cities (people per km^2)

x_s — population density of suburbs (people per km^2)

x_a — annual passenger number in 2010

The analysis resultants are shown in Table 3-2.

Model	R^2	P-Value	Conclusion About Equation
Model1: $y_a = 0.98x_s - 3.42E\text{-}04\,x_c + 1.78E\text{-}05x_a - 221$	*0.663*	β_c-*0.996*	Coefficient of x_c is not significant; model is not significant
		β_s-*0.209*	
		B_a-*0.113*	
Model 2: $y_{a/c} = 2.2E\text{-}09\,x_a + 0.157$	*0.066*	*0.577*	Model is not significant
Model 3: $y_{a/s} = 4.11E\text{-}08x_a + 0.287$	*0.642*	*0.03*	Model is significant

Table 2-2 Regression Resultants of Population Density Models

Source: By the author

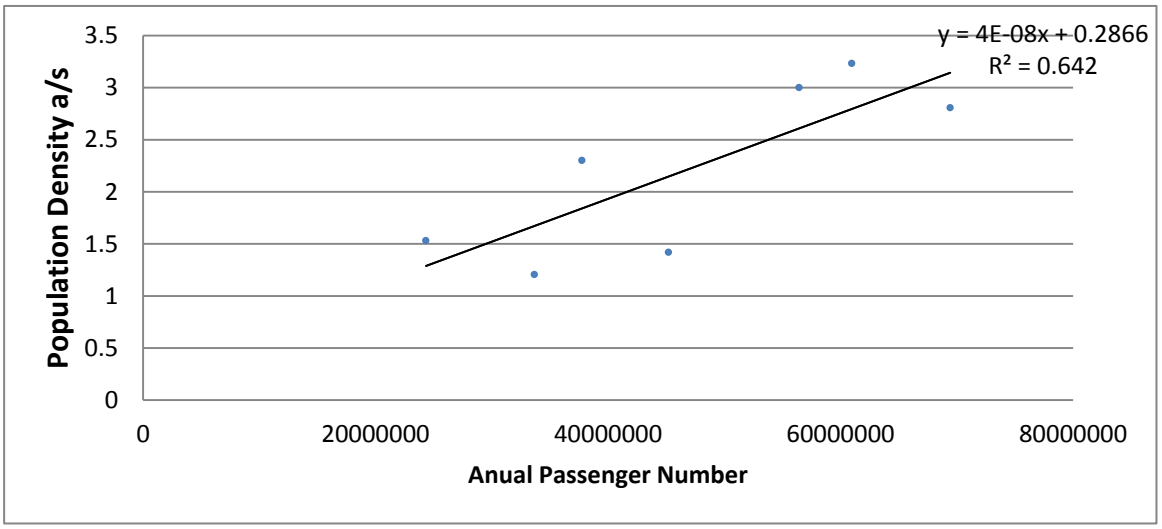


Figure 2-6 Regression Resultants of Model 3
Source: By the author

According to Table 2-2, the *P-value* of the coefficient β_c in model 1 is as high as *0.996*, which indicates that the population density of the city (explanatory variable x_c) is non-significant in influencing the population density of the airport region. This scenario is also further verified in model 2. In model 3, the R^2 statistic 0.642 suggests that 64.2% of the total variation of the population density in the airport region (dependent variable $y_{a/s}$) is explained by the capacity of the airport (explanatory variable x_a). The coefficient of the explanatory variable x_a with a p-value of 0.03 indicates that the coefficient is statistically significant at 97%-confidence level. Therefore, model 3 shows a strong positive relationship between the airport capacity and the variation of population density in the airport region, and the model could as well be used for estimating the variation of population density in these regions.

■ Regression Analysis of Airport Impact on Aging Population

Based on statistical data of annual passenger number and percentage of aging population in airport regions, airport-connected cities and suburbs of case study airports, ordinary least square regression models were employed in this work to investigate relationships between airport capacity and variation of population density in airport periphery. The level of confidence is 95%, and the model is presented in the following forms:

Model 1 $$y_a = \beta_c x_c + \beta_s x_s + \beta_a x_a + \varepsilon$$

Model 2 $$y_a = \beta_c x_c + \beta_a x_a + \varepsilon$$

Model 3 $$y_a = \beta_s x_s + \beta_a x_a + \varepsilon$$

Here:

y_a — percentage of aging population in airport region

x_c — percentage of aging population in the city

x_s — percentage of aging population in suburbs

x_a — airport capacity

The resultants of ordinary least square are presented in the following Table (2-3):

Model	R^2	*P-Value*	Conclusion About Equation
Model1: $y_a = 0.05 x_c + 0.657 x_s$ *-7.17E-08* $x_a + 5.78$	*0.886*	β_c*-0.791*	Coefficient of x_c is not significant; model is not significant
		β_s*-0.014*	
		β_a*-0.053*	
Model 2: $y_a = 0.432 x_c$ *-4.17E-08* x_a *+9.824*	*0.403*	β_c*-0.227*	Model is not significant
		β_a*-0.461*	
Model 3: $y_a = 0.68 x_s$ *-7.45E-08* x_a*+6.228*	*0.884*	β_s*-0.002*	Model is significant
		β_a*-0.021*	

Table 2-3 Regression Resultants for Proportion of Elderly People

Source: By the author

According to Table 2-3, although the determination coefficient R^2 is as high as 0.886, the *p-value* of the coefficient β_c is 0.791, so that the percentage of aging population in the city (explanatory variable x_c) is non-significant and does not statistically influence the percentage of aging population in the airport region. Both model 1 and model 2 are not significant, and could not be used for estimating the percentage of aging population in the airport area (dependent variable y_a). The determination coefficient R^2 is 0.886 in model 3, hence the model explains 88.6% of the variation in the percentage of aging population. The coefficient β_s, with a *p-value* of 0.002, indicates that the percentage of aging population in suburbs (β_s) is statistically significant at 99.8% confidence level. The coefficient β_a, with a *p-value* of 0.021, demonstrates that the coefficient of airport capacity (β_a) is statistically significant at 97.9% confidence level. Therefore, both the capacity of the airport and the percentage of aging population in the suburbs are significant and statistically affect the aging population in the airport neighborhood. Moreover, model 3 could be used for estimating the variation in the percentage of aging population in the airport region based on the adjacent airport's capacity and the mean percentage of aging population in the suburbs.

2.5 **Conclusive Summary**

Several conclusions could be drawn from the above statistics and analyses.

First, it is commonly assumed that the larger the airport capacity (i.e., passenger traffic, flight frequency, air freight volume), the more negative influences the airport-surrounding communities will suffer, and thus the more risks the airport will pose to social development of such localities. However, according to statistical data and regression resultants obtained in this study, along with economic development, social development is not stalled by negative airport influences. Significant regression models even show that the passenger traffic flow has positive influences on population growth and aging population decrease in surrounding communities. Therefore, we could conclude that airports should not be considered as a "barrier" to urban development, but rather as a significant influencing factor of regional revitalization and social development, at least in promoting urban activities and improving the social structure by attracting young families.

Second, the above regression resultants also showed that the population density and aging in an airport region mainly depends on the passenger traffic of the neighboring airport, but do not relate to the airport-connected city. Therefore, we could conclude that the economic and urban development of an airport region is mainly based on the influence of its neighboring airport, but not of the city. Besides, the urban formation of airport regions also presented obvious independent airport-related characteristics, and expresses to which extent the population density in these areas will increase compared to other suburban regions.

In an airport development or expansion project, the regression resultants obtained in this work could be used to estimate the changes in population density and aging in the future airport region, thus serving as planning and strategy-making preconditions for town planners and authorities. Furthermore, the regression analysis could also be used in communities adjacent to an existing major airport, and to confer whether the realistic population density and aging match the regression resultants, as a basis for adjusting existing plans and strategies.

3 Community of Complexity – Focus on Land Use

3.1 **Preliminary Study**

■ Literature About the Airport Region Planning

In "The Airport City Development Concepts for the 21st Century"[40], H. McKinley Conway, as an airport planning consultant, indicated: Since there was not a "substantial body of literature on fly-in development", he gathered information from the FAA and other aviation associations. His book is a fascinating look at early ideas regarding airports and their place within the larger transportation and urban network. "By relocating your factory to the airport, you avoid the congestion!" In advocating for this airborne future, he describes the vision as "the ultimate marriage of executive, plant, and airplane"[41].

As corporate supply chains have gone global, the proto-formulae introduced by Conway are currently coalescing into hard economics for many firms. For companies ranging from the pharmaceutical industry over semiconductor fabrication to management consulting, the reasons to be located near airports have become evident, as customers and suppliers at present span the globe. Just-in-time manufacturing and other new "best practices" take advantage of fast transportation: this, most often, means going by air[42].

Into this scene enters Dr. John Kasarda. From the worlds of corporate strategic planning, site selection, urban planning and real estate, this management professor has risen to become the foremost expert on the "aerotropolis". With an MBA and a PhD in Sociology, his curriculum vitae can be read as a historiography on the rise of the airport city concept[43]. In his consultancy, Kasarda encourages all kinds of businesses to establish themselves in the greater aerotropolis. Just as central cities have a broader metropolis, he proposes the spatial form of a central airport city and a broader aerotropolis. In many of his presentations, he notes that most major international airports today derive more revenues

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[40] John D. Kasarda, "The Evolution of Airport Cities and the Aerotropolis," *Airport Cities: The Evolution*, 2008, 23.

[41] John Good, *Aerotropoli-The Logic of Globalization and the Rise of Dr. John Kasarda* (Globalization Space Final Research Paper, December 2007), 2.

[42] John Good, *Aerotropoli-The Logic of Globalization and the Rise of Dr. John Kasarda* (Globalization Space Final Research Paper, December 2007), 3.

[43] Kenan Institute (John Kasarda's Curriculum Vitae), especially pp. 3-5

from non-aeronautical sources than from aeronautical ones[44] Thus, he proposes a master-planned form for these new developments, as represented below on a plot of function and size versus liberalization and deregulation levels.

Dr. Kasarda's vision is based on this spectacle: More than just an extension of formulae, the central airport city should be home to a wide variety of services catering to the traveler, forming the core of the aerotropolis. This includes the primary infrastructure of the airport runways and terminals connected to a multi-modal transportation infrastructure[45]. On top of this would be flex-use offices for traveling professionals and small companies, hotels, convention centers and cargo terminals, as well as shopping arcades for the masses. This airport city is just the center of a much larger aerotropolis ecosystem, as can be seen in the two following pyramids of Figure 3-1.

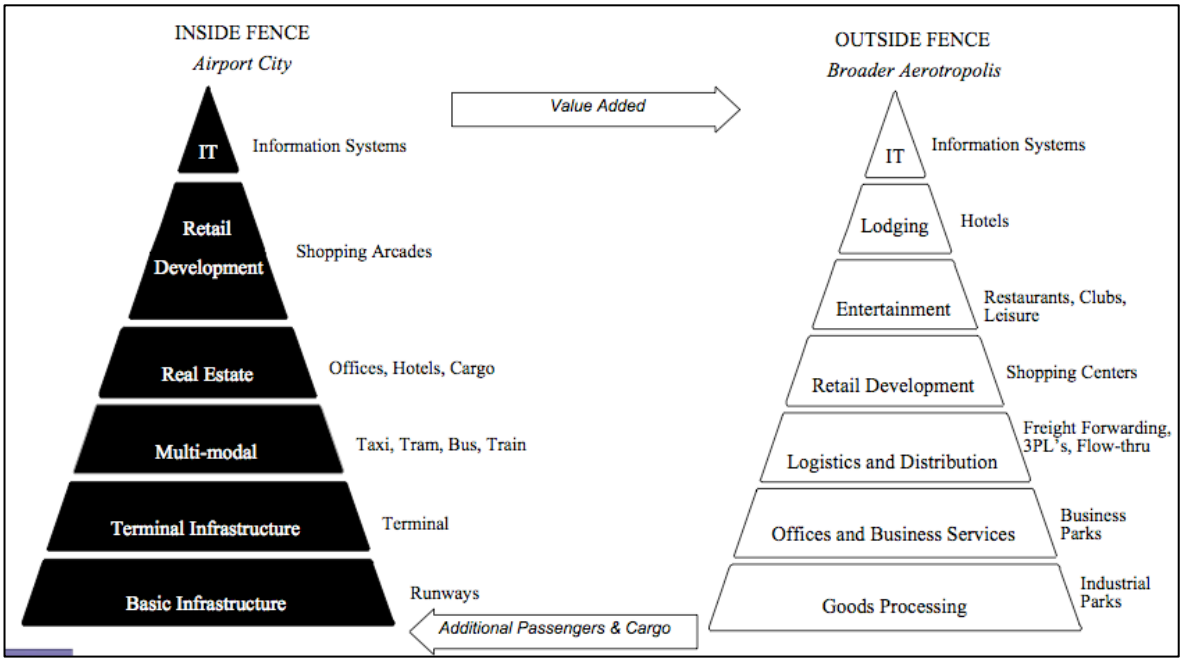

Figure 3-1 Airside vs. Landside
Source: Kasarda, "Designing an Aerotropolis to Provide Michigan's Competitive Advantage", p. 16

Dr. John Kasarda's vision aims at something much greater than a glorified airport with some adjacent warehouses; the broader aerotropolis would contain research and technology parks, hotels and entertainment districts, just-in-time manufacturing, tourist attractions, and mixed-use residential areas. As free-trade zones and deregulation decrease, the composition would shift from warehouses and e-fulfillment centers to corporate campuses,

[44] John Kasarda, *Designing an Aerotropolis to Provide Michigan's Competitive Advantage*, Urban Design Charrette: Aerotropolis (The Kenan Institute of Private Enterprise, January 2006), 10.

[45] John Kasarda, *Designing an Aerotropolis to Provide Michigan's Competitive Advantage*, Urban Design Charrette: Aerotropolis (The Kenan Institute of Private Enterprise, January 2006), 11.

hospitals, and high-tech. With mixed-use residential and retail areas, this is really the first part of the theoretical ringed scheme that would traditionally be called a "city". The airport area finally develops a "brand image", attracting even non-airport-linked businesses. Thus, Kasarda advocates for nothing less than creating whole new airport-themed urban zones within regions.

■ Uncertainties of the Airport City Development Model

Although globalization warrants development, and governments, businesses, as well as consultancies are pushing for investment, there are still much criticism about the intensive urban development model. Martin J. Gannon questions whether it is really possible to create and operate an airplane-based metropolis for efficient global logistics and transportation. He predicts that even though there will be robust economic incentives, a rise in air cargo shipment will bring durable resistance to the growth of aerotropolises because many will view them as "environmentally detrimental and unsound"[46].

Additionally, there are also worries that airplanes, over the long term, could be unsustainable, given that jet engines need fossil fuel inputs. In Charles et al.'s critique of the aerotropolis model, published in November 2007, they note that "building an aerotropolis, i.e., an industrial complex and urban community based around the central hub of an airport, necessitates the continued existence of the one thing that makes it all possible… hydrocarbon-based fuel". Also, while biofuels and hydrogen show some promise, they have their own problems; biofuels have a net energy loss and it would take at least 15-20 years to retrofit engines for hydrogen[47].

Private stakeholders necessary for the aerotropolis development could break down at any time. Either they realize the inherent contradictions present in the proposal, or changing economics of global warming make people question the long-term viability of centering development on what could be an obsolete transportation mode.

■ Land Use Changes by Airport Impact

According to Glen E. Weisbrod and John S. Reed Roanne Wirth[48], airport-surrounding communities could be categorized in two types: First, communities adjacent to the airport;

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[46] Martin J. Gannon, *Paradoxes of Culture and Globalization* (SAGE, 2007), 219.

[47] Good, *Aerotropoli-The Logic of Globalization and the Rise of Dr. John Kasarda*, 2.

[48] Glen Weisbrod and John Reed, "Airport Area Economic Development Model" (presented at the PTRC International Transport Conference, Manchester, England, 1993), 4.

second, communities in the vicinity of the airport and airport access corridor.

The land use of airport-adjacent communities mainly includes[49]:

1. Services directly supporting operation of the airport (flight kitchens, aircraft maintenance services);
2. Services for airline employees and passengers (hotels, restaurants and additional car rental, etc.);
3. Airport-related freight services (shipping, freight forwarding, customs and sometimes a foreign trade zone).

Based on the GIS analysis of case study airport regions, we found that the greatest concentration of business activity around an airport is within 6 km of it, or along an access corridor within 15-minute time to the airports. Developments in these areas are either "spin-off industries" or "attracted businesses". Spin-off industries include petrol filling stations, lodging and housing for airport workers, and retail trade serving them. These activities grow directly with airport activity levels, although they often take 5 to 10 years or even longer to grow. Attracted businesses are not related to the airport supply chain, which value the location near an airport because of its prestige, air services and by accessibility for visiting customers and employees coming by air[50].

New business activities may be attracted from outside of the area because of the prestige and improved customer access provided by enhanced domestic and international air service of large commercial airports. These new activities may include[51]: (a) regional or national corporate headquarters of large national and multi-national companies; (b) trade and merchandise centers marketing retail or industrial products; (c) service companies that are dependent on air service to reach their markets; and/or (d) airlines and related activities. Expansion of activities in the metropolitan area occur for types of businesses that are users of airport services, suppliers to markets generated by the airport, or businesses that can take advantage of the local transport and other supporting infrastructures developed primarily to serve the airport. These are typically: (a) high-tech electronics and specialized equipment manufacturers, (b) communications companies, (c) warehouse and delivery

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[49] Glen Weisbrod and John Reed, "Airport Area Economic Development Model" (presented at the PTRC International Transport Conference, Manchester, England, 1993), 2.

[50] Glen Weisbrod and John Reed, "Airport Area Economic Development Model" (presented at the PTRC International Transport Conference, Manchester, England, 1993), 3.

[51] Glen Weisbrod and John Reed, "Airport Area Economic Development Model" (presented at the PTRC International Transport Conference, Manchester, England, 1993), 3.

services, and (d) a variety of specialized business services.

Hotel and convention facilities are another rapidly expanding type of business. The magnitude of these developments is closely related to the passenger volume of the airport. The ratio of hotel rooms (within 6 km of the airport) per thousand airport passengers (annually) ranges in Europe from 0.06 (Paris/Orly) to 0.13 (London/Gatwick), while in North America it ranges from 0.10 (Dallas/Ft. Worth) to 0.21 (Chicago/O'Hare)[52]. The supportable number of hotel rooms is predictable based on four factors: (1) extent of hub versus destination travel, (2) airport location relative to office activity centers, (3) hotel agglomeration at conference centers, and (4) land-use restrictions[53].

Retail is yet another rapidly growing type of business activity. Shopping facilities are being expanded and upgraded at many airports. Airport-vicinity shopping centers are also increasing, following the nearby population growth.

3.2 **Impact of Distance to Airport on Land Use Distribution**

In Dr. John Kasarda's theory, large international airports should be considered as a new development core, which attracts urban development of all kinds and forms the new aerotropolis with full city functions. Unlike traditional urbanization, that of airport-surrounding areas is developed mainly based on its geographic core – the airport expands from the core to its periphery, and the periphery suffers both negative and positive impacts at different levels. For example, like other kinds of traffic infrastructure, airports are conductive in clustering its related industries, business and tourism. However, some of its negative impacts, like noise, air pollution or water pollution, will restrain the development of residential, educational or health care facilities. Therefore, the hot spot analysis study was done in order to: 1.) better understand the airport impact range on land use distribution; 2.) investigate a certain land use's distribution features under airport impact in different scopes; 3.) better understand the differences in the urban development process between airport-neighboring communities, airport-connected cities and suburb rings.

In order to investigate the land use distribution features in different ranges, the study

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[52] Glen Weisbrod and John Reed, "Airport Area Economic Development Model" (presented at the PTRC International Transport Conference, Manchester, England, 1993

[53] Glen Weisbrod and John Reed, "Airport Area Economic Development Model" (presented at the PTRC International Transport Conference, Manchester, England, 1993).

scopes are considered as concentric circles with radius of 6 km, 9 km, 12 km and 15 km, and takes airports as the circle centers (Figure 3-2). The selected study land use includes industrial, commercial, educational and research facilities, as well as residential and sport and leisure ones. The industrial land use includes manufactures, workshops, warehouses, logistic centers, etc. The commercial land use includes retail trade, supermarkets, office buildings, hotels and other hospitality facilities. Higher education and research land uses include universities, colleges, laboratories, research institutions and other research and higher educational facilities. Residential area includes all types of dwelling facilities. At last, sport and leisure land use includes stadiums, sport centers, recreation grounds, pitches,

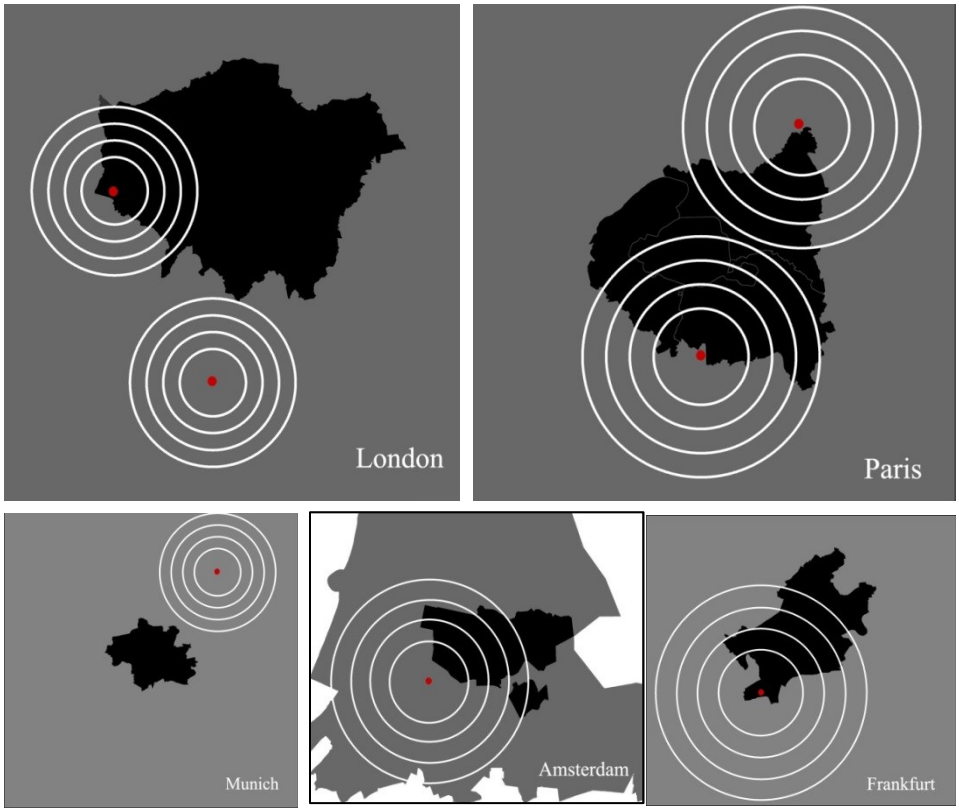

Figure 3-2 Research Scope of the Case Study Cities of London, Paris, Munich, Amsterdam and Frankfurt
Source: By the author

gardens and golf courts.

The data on land use distribution in the case study cities were obtained from OpenStreetMap (www.openstreetmap.org), and integrated with the ground traffic network on the ArcGIS platform. The proportion of each land use was calculated in concentric circles, which took seven case study airports as circle centers, with a radius of 6 km, 9 km, 12 km and 15km. The mean proportion of each land use in five case study cities and their connected suburbs were also calculated for further statistics (Table 3-1).

Industrial	6 km	9 km	12 km	15 km	City	Suburb ring
Paris CDG	9.281	8.865	5.934	4.265	4.436	1.995
Paris Orly	6.517	5.839	4.473	3.910	4.436	1.995
London Heathrow	5.224	3.472	2.606	1.587	3.413	0.734
London Gatwick	1.805	0.931	0.750	0.525	3.413	0.734
Amsterdam	3.806	5.467	7.672	5.978	11.490	2.344
Frankfurt	3.566	3.731	3.289	2.991	6.361	0.888
Munich	0.482	0.485	0.417	0.421	4.088	0.659
Commercial	6 km	9 km	12 km	15 km	City	**3.2.1.1** Suburb ring
Paris CDG	0.888	0.860	0.721	0.521	1.421	0.524
Paris Orly	2.839	1.942	2.490	2.084	1.421	0.524
London Heathrow	2.296	1.797	1.619	1.587	2.613	0.332
London Gatwick	0.531	0.269	0.191	0.230	2.613	0.332
Amsterdam	3.484	2.247	1.426	1.162	1.509	0.343
Frankfurt	0.447	1.411	1.928	1.653	1.650	0.580
Munich	1.243	0.810	0.699	0.544	1.571	0.422
Education	6 km	9 km	12 km	15 km	City	**3.2.1.2** Suburb ring
Paris CDG	0.198	0.397	0.388	0.392	1.706	0.339
Paris Orly	1.270	1.443	1.639	1.577	1.706	0.339
London Heathrow	1.255	1.919	1.758	1.566	2.007	0.432
London Gatwick	0.616	0.298	0.274	0.272	2.007	0.432
Amsterdam	0.098	0.229	0.208	0.208	0.481	0.041
Frankfurt	0.147	0.340	0.373	0.443	0.907	0.124
Munich	0.117	0.216	0.164	0.130	1.133	0.085
3.2.1.3 Residential	6 km	9 km	12 km	15 km	City	**3.2.1.4** Suburb ring
Paris CDG	11.420	17.529	22.260	26.945	59.736	14.486
Paris Orly	19.926	26.076	29.772	33.421	59.736	14.486
London Heathrow	21.081	24.322	24.337	24.843	45.212	9.473
London Gatwick	19.344	12.971	12.446	11.519	45.212	9.473
Amsterdam Schiphol	14.929	21.556	20.952	20.003	25.080	13.420
Frankfurt	7.079	12.931	17.045	17.984	25.243	8.535
Munich	6.696	6.499	6.412	6.659	26.902	7.382
Leisure	6 km	9 km	12 km	15 km	City	Suburb ring
Paris CDG	0.180	0.454	0.352	0.475	2.380	1.110
Paris Orly	1.942	1.859	2.121	2.266	2.380	1.110
London Heathrow	4.079	5.094	5.917	6.323	5.502	1.714
London Gatwick	1.670	1.571	1.776	2.037	5.502	1.714
Amsterdam	2.114	2.695	2.270	2.076	2.988	1.419
Frankfurt	0.250	0.939	1.271	1.307	2.422	0.478
Munich	0.297	0.224	0.459	0.485	2.732	0.560

Table 3-1 Land Use Density (Percentage) in 6-km, 9-km, 12-km and 15-km Radius Circle Scopes and Land Use Density of City and Suburb Rings

Source: By the author according to Statistical Data from the Statistic Bureaus of Each Case Study City

Statistical diagrams were generated according to the above table for investigating the airport impact scope of different land uses. The distribution features, in accordance with various distances of each selected land use, are also shown in these graphs, as follows.

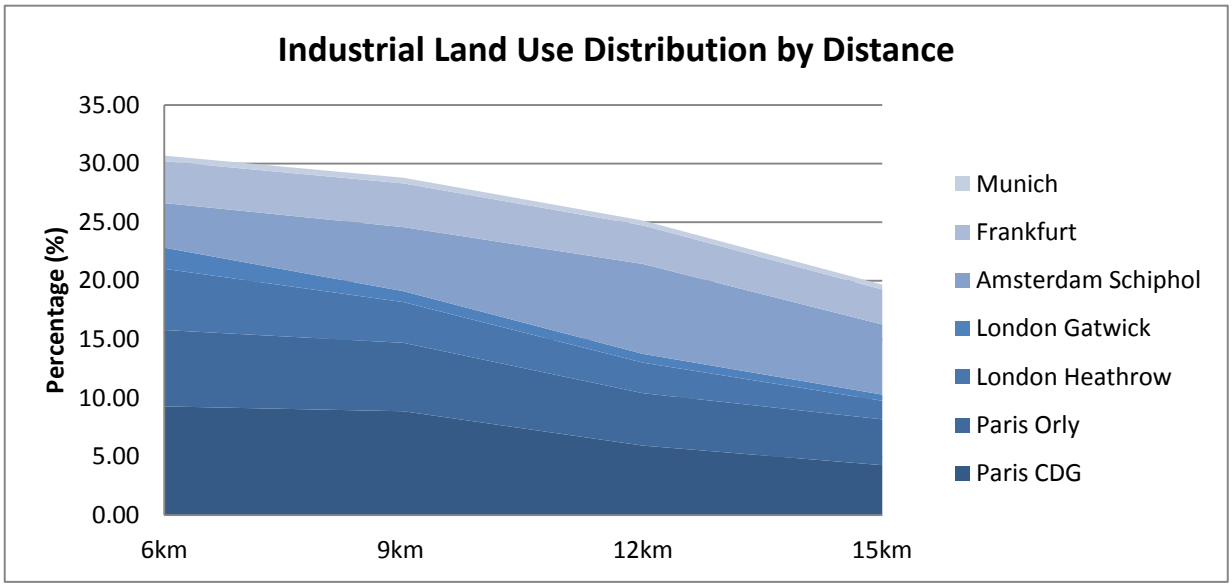

Figure 3-3 Statistics of Industrial Land Use Distribution by Distance in Case Study Airport Regions
Source: By the author

According to Figure 3-3, all case study airports except Amsterdam Schiphol show a tendency of industrial land use distribution by distance to the airports. The industrial land use density within the scope of 6-km distance to airports is the peak value, gradually decreasing as far as the 9-km radius circle from the airports, and then further decreasing as far as the circumference of 15 km. The graph shows that the airport has significant cluster effects over industrial facilities. The densest industrial zone is formed at the closest circle around the airport. Moreover, the airport-related industries normally clustered within a scope of 9-km distance from the airport, and the positive impacts from airports such as short traveling time, goods transportation, accessibility, etc., start to decrease at a distance of 9 km to the airport.

A common feature of commercial land use distribution by distance to the airport is clearly shown in Figure 3-4. The peak value of commercial land use distribution is within a scope of 6-km distance to airports. From this scope, the density of commercial land use sharply decreases as far as the 9-km scope. The interval between 9 km and 12 km is shown as equal or similar. In some specific airports, such as Paris Orly or Frankfurt Airport, the value of commercial density at the 12-km critical point is even higher than at the 9-km point. The density of commercial land use starts to decrease to the average urban commercial land use density from a distance of 12 km to 15 km.

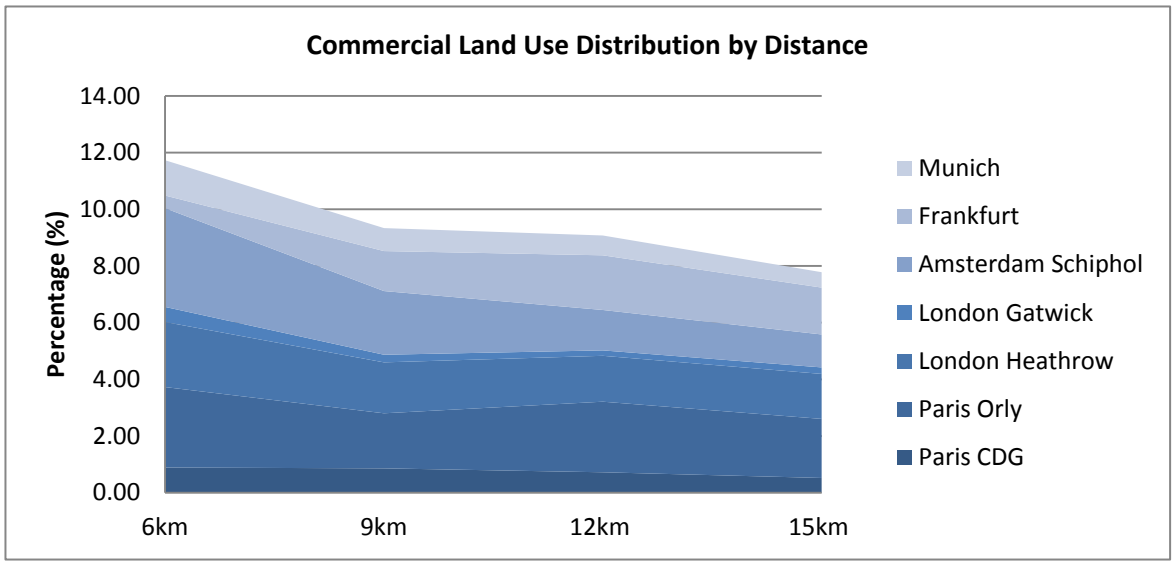

Figure 3-4 Statistics of Industrial Land Use Distribution by Distance in Case Study Airport Regions
Source: By the author

Figure 3-4 could serve as a reference for commercial land-use planning in airport regions. Because the highest density of commercial land use is clustered in a scope of 6-km of the airport, then such scope could be considered as the range of the airport city, which contains the highest density of commercial facilities that directly serve the airport, such as airport on-site retails, hotels and business parks. The distance of 9 to 12 km to airports, according to common commercial land use distribution principles, could be considered as new commercial hot spots at airport-surrounding communities. A density analysis of commercial distribution features was done in the next chapter to prove, using some case study airport regions, that the commercial land use density in community centers is even higher than the average commercial density in the urban region of airport-connected cities.

Figure 3-5 shows that the residential land use distribution is opposite to that of industrial and commercial purposes. Unlike the common land use features of these, the value of residential land use distribution is inversely proportional to the distance to airports. The longer the distance to the airport, the higher the density of residential land use. This is not difficult to understand with a 6-km scope of an airport; here, residential land use density is extremely low because of the noise impact from the airport.

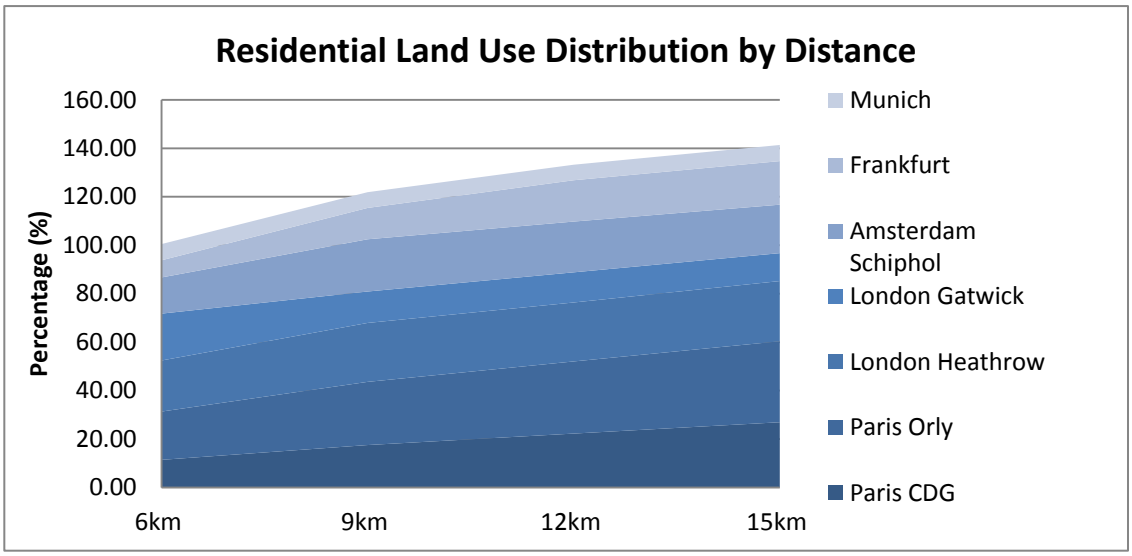

Figure 3-5 Statistics of Residential Land Use Distribution by Distance in Case Study Airport Regions
Source: By the author

Although airports have great negative impacts on attracting residential land use, according to statistics on population density of case study airport regions, this density is generally higher than in suburban rings (Figure 3-6). On one hand, airport noise is the main obstacle of residential development. On the other hand, convenient access, more job opportunities and high cost-performance housing and rental pricing may also attract new inhabitants to relocate into the airport region.

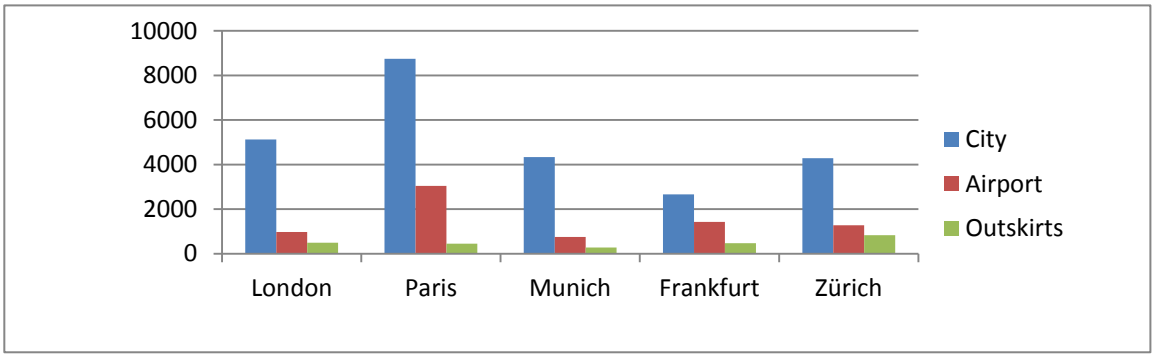

Figure 3-6 Population Density in Case Study Cities, Airport Regions and Outskirts
Source: By the author

It is important to note that original residents, who do not have a direct relationship to airport-related businesses, will suffer the negative impacts, but not enjoy the benefits of the airport. Therefore, instead of attracting newcomers into the airport-surrounding community, it should be one, though not the only, aim of local training programs or localized vitalizing programs to build connections between original local residential use and airport-related businesses. They should be continuously led by airport operators and local authorities to satisfy the residents, solve unemployment problems, and compensate labor shortage with airports and their related industries.

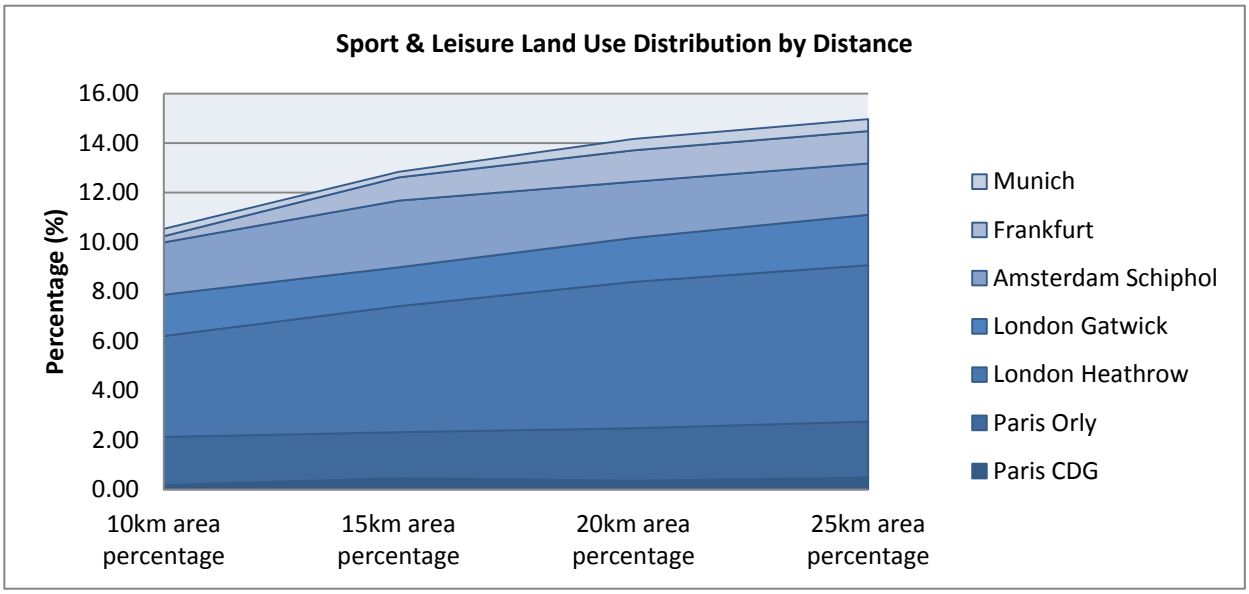

Figure 3-7 Statistics of Sport and Leisure Land Use Distribution by Distance in Case Study Airport Regions

Source: By the author

Figure 3-7 shows that the distribution of sport and land use facilities follows the trend of residential land use distribution: The shorter the distance to airports, the lower the density. However, airport impacts on sport and leisure land use are different depending on the types of sport and leisure facilities. According to the GIS study, although the sport and leisure land use density around airports is lower than airports, in certain sport types such as golf and riding the density is much higher than in the city or in other suburban regions.

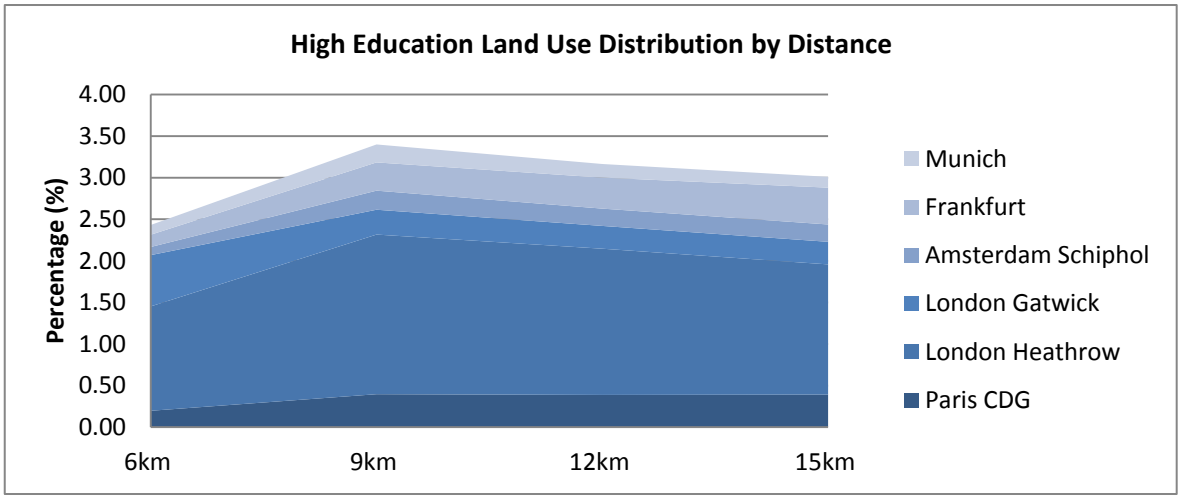

Figure 3-8 Statistics of High Education and Research Land Use Distribution by Distance in Case Study Airport Regions

Source: By the author

Figure 3-8 shows the higher education and research land use distribution tendency. The lowest points of educational and research land use are found within a 6-km scope. From there, the density starts rising sharply until its peak value at 9 km, and from there slowly decreases as far as the 15-km scope. This indicates that, because of the superior

accessibility of airports and also because high-tech business/manufacturing are closely related to universities and research institutions, educational and research facilities may find certain convenience in being located near an airport. However, according to noise control programs, new educational and research facilities are rarely built within 65 dB of the airport noise zone. Moreover, research facilities are less directly related to airports and more directly to air-related industries/businesses, so that research facilities are rarely built inside the 6-km scope, but more often in the scope of 6-9 km, or even farther.

3.3 **Airport Capacity Impact on Land Use Distribution**

As mentioned before, another important factor of airport impact on land use distribution is the airport capacity. In this study, this aspect is considered as the number of annual passengers and the total amount of annual air cargo (tons). Moreover, because it is evident that airport-related employees may settle in the airport-surrounding communities, participate in the social instances and utilize local service facilities in these communities, the number of airport employees is also included in the study of airport capacity impacts on land use distribution on the airport-encircling region.

Airport Name	IATA Code	Passenger		Freight & Cargo Amount (Ton)	Site Area Employees
		1.1 Number	E.U. Ranking		
Amsterdam Schiphol	AMS	45,211,749	4	1,538,135	61,700
Frankfurt am Main	FRA	53,009,221	3	2,275,106	71,500
London Heathrow	LHR	65,884,143	1	1,551,405	70,000
London Gatwick	LGW	31,378,644	10	107,720	25,000
Munich	MUC	37,763,701	7	286,201	28,000
Paris Charles de Gaulle	CDG	58,167,062	2	2,399,067	75,000
Paris Orly	ORY	27,139,076	12	95,098	26,000

Table 3-2 Ranking and Capacity of Case Study Airports
Source: “Airports Council International - Preliminary Worldwide Airport Traffic Report - Calendar Year 2010”

The aim of this study was to explore, based on the above studies of “airport impact range on land use distribution”, the correlation between airport capacities and the degree of different land use clusters. For example, because air cargo is closely related to industrial development, based on the assumption that there may be correlation between the capacity of air cargo and the industrial and logistic land use development, a regression study was

done in order to:

1. Explore the existence of the correlation or tendency of airport cargo capacity and airport-surrounding industrial land use clusters;
2. Explore in which scope the correlation (coefficient of determination) shows the most reliable results;
3. Analyze the result of the regression study, and test its reliability.

In order to investigate the correlation of airport capacity impact on land use distribution, regression studies were performed and considered x and y as shown in the Figure 3-9.

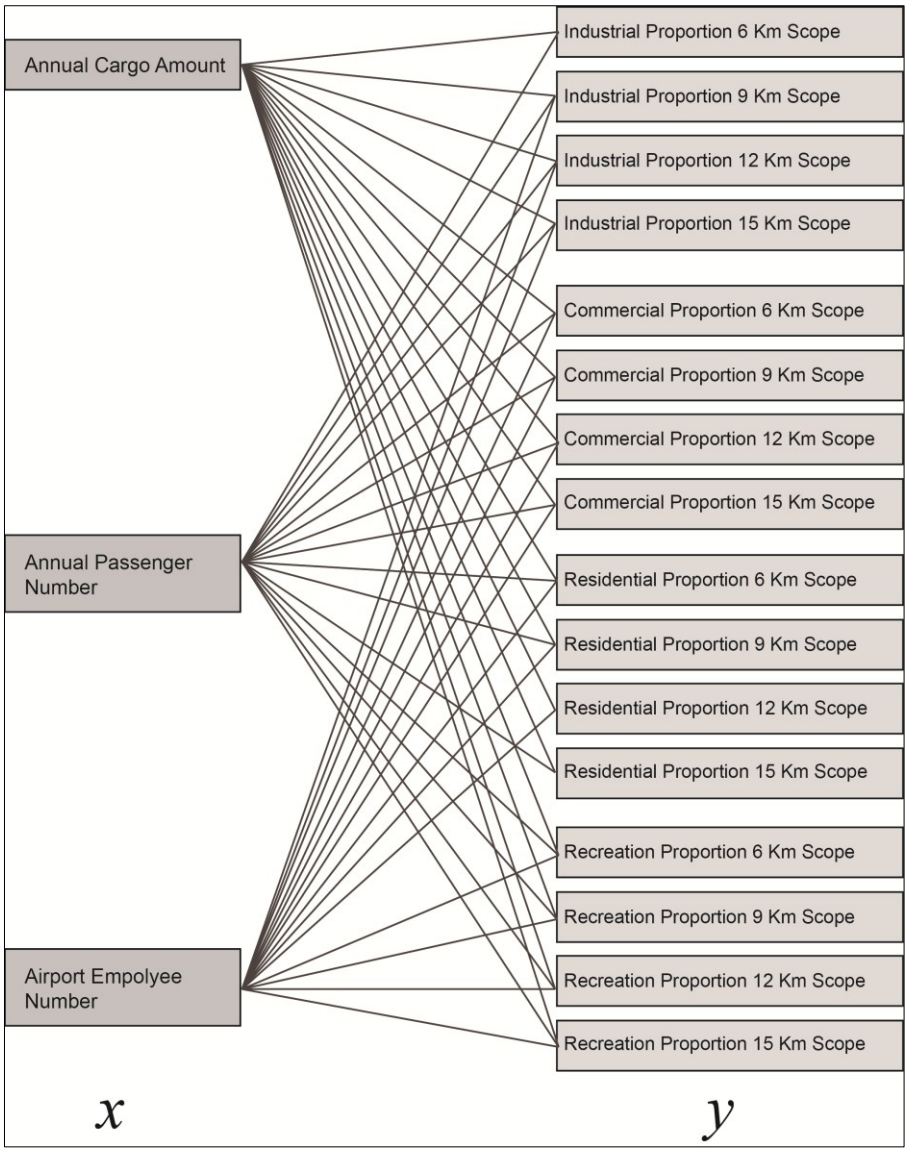

Figure 3-9 Attempts of Regression Calculation for Investigating the Correlation Between Airport Capacity and Land Use Distribution

Source: By the author

According to results of regression attempts, correlation between airport capacity and land use distribution has been found. Moreover, the annual airport passenger number and airport staff have a close correlation with residential land use distribution, and the annual airport passenger number has a correlation with commercial and business land use distribution. The correlation between recreational/educational land use distribution and airport capacity is not clear.

3.3.1 Airport Cargo Capacity Impact on Industrial Land Use Clusters

In the regression study, *y* is considered as the amount of annual air cargo (tons), and *x* is the proportion of the industrial area in case study airports. The significance level is considered as 95%. Linear regression studies were carried out four times (Figure 4-15), considering *x* in different scopes in order to find out in which one the correlation would be most evident (with the highest coefficient of determination R^2), and could hence be used for estimating the area of industrial land use around a new airport. The scopes of these regressions are considered as areas within 6-km, 9-km, 12-km and 15-km distance to airports. The regression results are as shown in Figure 3-10.

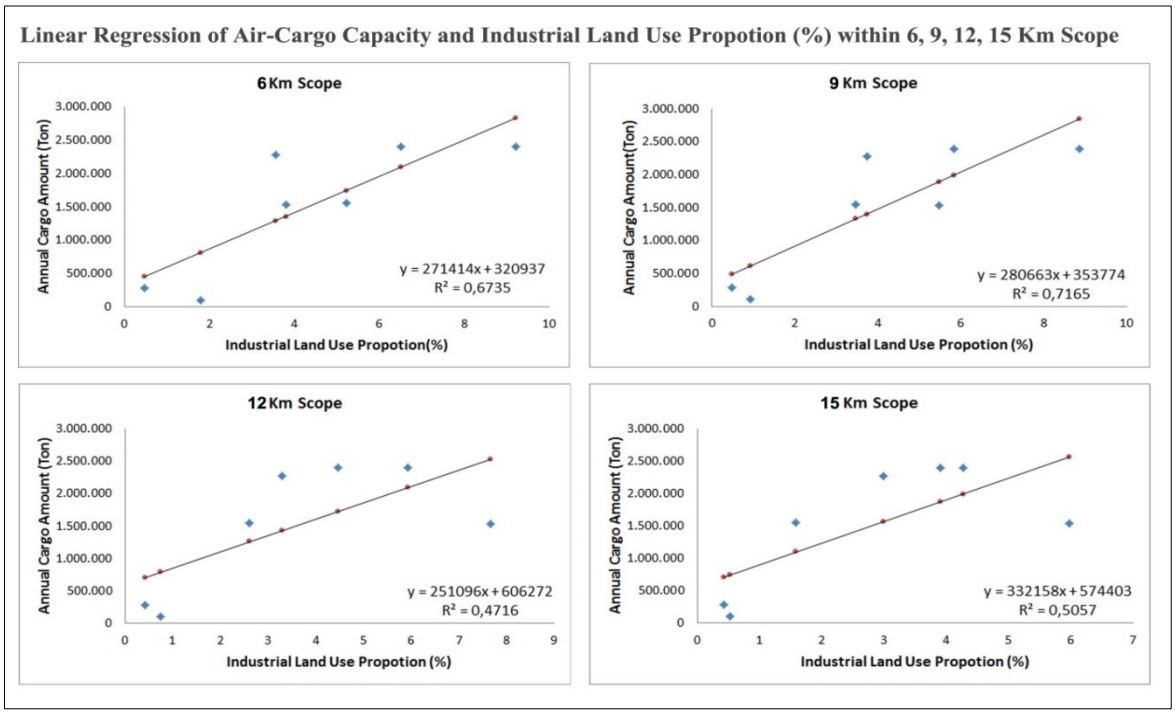

Figure 3-10 Linear Regression of Annual Air-Cargo (Tons) and Industrial Land Use Proportion (%)
Source: By the author

According to the above regression results, the most significant correlations with the highest coefficients of determination are found within the scopes of 9 km (R^2=0.716) and 6 km (R^2=0.673) from the airport. This proves that an airport does not only have great cluster effect on industrial land use development, but the volume of industrial land use as an unknown factor could also be estimated based on air cargo capacity.

3.3.2 Number of Airport Employee and Passenger Impact on Residential Land Use Clusters

- **Correlation Between the Number of Airport Employees and the Proportion of Residential Land Use**

ACI Europe has estimated[54] that, on average, for every 1,000 on-site jobs supported by European airports there are around 2,100 indirect/induced ones supported nationally, 1,100 indirect/induced jobs supported regionally, or 500 indirect/induced jobs supported sub-regionally. It is given that there are 950 on-site jobs created per million passengers. Once these factors of direct, indirect and induced jobs could be predicted, for every million passengers, European airports support around:

- 2,950 jobs nationally;
- 2,000 jobs regionally;
- 1,425 jobs sub-regionally.

Although airports have obvious negative impact on housing prices in airport-surrounding localities, statistics and literature show that communities around airports have higher population density than suburbs or rural regions. Literature also shows that a certain amount of airport-related employees who have airport-indirect/induced jobs may possibly settle in airport-neighboring regions because of shorter commuting time. For example, almost 50% of employees working at Heathrow live in the five boroughs around the airport. This equates to around 1 in 15 of the working population within Heathrow's local communities[55]. Taking Frankfurt airport as another example, there is approximately 60% of airport staff living within a scope of less than 35 km to the airport[56]. As for the Charles de Gaulle airport, it has an amount of 65,000 on-site employees and 28% of them residing in the 63 communes located within 15 km of the airport[57]. Therefore, the number of airport employees may correlate with the residential land use density in airport regions.

In these regressions, y is considered as the total amount of airport employees, according to

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[54] The Social and Economic Impact of Airports in Europe. Airport Council International (ACI), January 2004.

[55] *Towards a Sustainable Heathrow* (London, UK: Heathrow Airport Limited, 2010).

[56] Robert Payne, *2012 Facts and Figures on Frankfurt Airport* (Frankfurt am Main, Germany: Fraport AG Frankfurt Airport Service Worldwide, March 2012).

[57] The social and Economic Impact of Airports in Europe, ACI (Airport Council International) Europe, Jan. 2004

statistics of each case study airport operator. *x* is the proportion of residential land use in case study airport regions. The significance level is considered as 95%. Linear regression studies were also carried out four times (Figure3-11), considering *x* in different scopes in order to find out in which one the correlation would be most evident (with the highest coefficient of determination R^2), and in which one the result of the regression could be most significant as guidance in estimating the area of residential land use around an airport based on the number of airport employees. The regression results are as shown in the charts below (Figure 3-11).

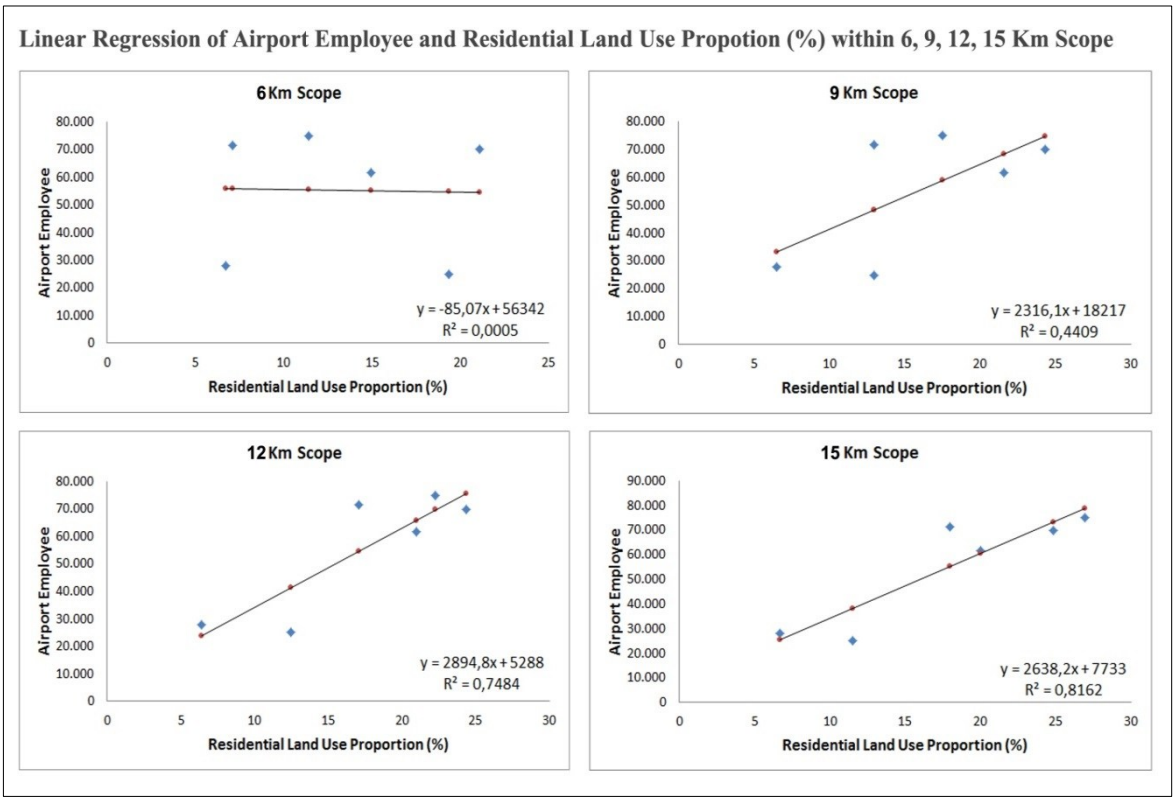

Figure 3-11 Linear Regression of the Number of Employees and Residential Land Use Proportion Within a 6, 9, 12 and 15-km Scope
Source: By the author

According to the above regression results, the number of airport employees impacts the proportion of airport-surrounding residential land use, as follows:

The airport noise impact on the correlation between the proportion and the number of employees will endure from the 6-km to the 9-km scope. The residential land use within a 9-km distance to the airport already showed a tendency of following the amount of airport employees. However, because the coefficient of determination (R^2) is only 0.4409, the regression results within a 9-km distance to the airport are not enough supportive as a guide for assuming the proportion of residential land use for communities inside a 9-km scope.

The correlation between the number of airport employees and the proportion of residential land use starts at the scope of 12-km distance to the airport, and endures up to 15 km or even farther. This means that, in general, starting at 12-km distance to an airport, the noise impact on residential units gets lower towards an acceptable rate, and the land value also gradually decreases, so that the cost-efficiency rate to residential and commercial land use development gets similar. With a high coefficient of determination, the result of the regression model is strong enough to be a reference in deciding upon residential land use proportion around a newly opened airport.

- **Correlation Between Annual Passenger Number and Proportion of Residential Land Use**

According to statistics of ACI (Airport Council International) Europe, there is a correlation between the number of annual airport passengers and the number of airport employees[58]. 950 airport on-site jobs are provided per million passengers. Therefore, the more the number of airport passengers, the more on-site jobs as well as indirect and induced jobs will be offered. Moreover, a large amount of airport passengers will also promote the local hospitality and service industries in nearby communities, which may attract new inhabitants to live within the airport region. Therefore, the hypothesis was created that there might also be a correlation between the amount of annual passengers and the proportion of residential land use in airport-surrounding communities.

Regression study was done considering y as the amount of annual passengers in each case study airport, and x as the proportion of residential land use in each airport-neighboring community around case study airports. The regression study was also performed within different scopes, in order to investigate in which range a correlation between the two factors would be most evident. The result is shown on Figure 3-12.

[58] *The Social and Economic Impact of Airports in Europe* (Airport Council International (ACI), January 2004)

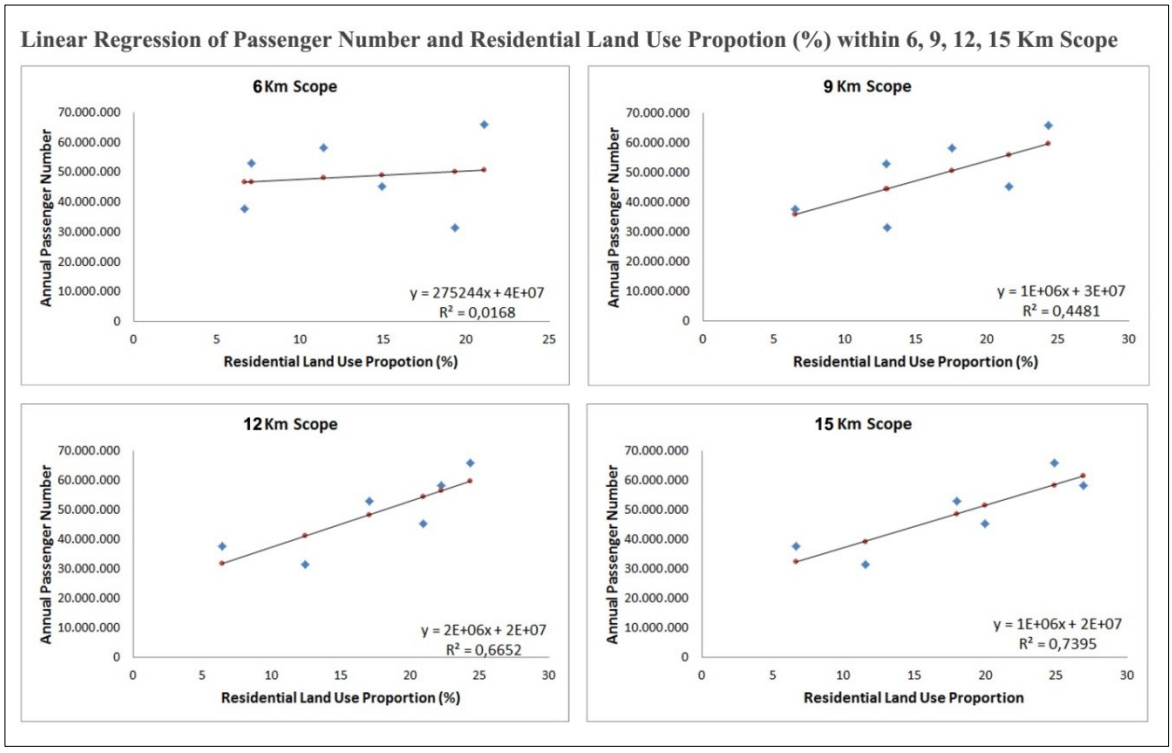

Figure 3-12 Linear Regression of the Number of Annual Passengers and Residential Land Use Proportion within 6, 9, 12 and15-km Scope in Case Study Airport Regions

Source: By the author

According to the results above, a tendency towards a correlation between airport annual passenger number and proportion of residential land use appears at the scope of 9-km distance to the airport. Nevertheless, the coefficient of determination is not enough to support the prediction of residential land-use planning around a new airport.

The correlation between an airports' annual passenger number and the proportion of residential land use starts at the range of 12-km distance to the airport, and the evidence lasts as far as the 15-km scope. Thus, the regression result could be used for predicting the volume of residential land use based on the annual passenger number for an airport region, thus serving as reference for control of residential land use development in them.

3.3.3 Number of Airport Passenger Impact on Commercial Land Use Distribution

- **Correlation Between Airport Annual Passenger Number and Commercial Land Use Development**

Regression analysis was also done for exploring the correlation between the amount of airports annual passengers, number of airport employees, annual cargo volume and

proportion of commercial land use in different scopes. The commercial land use in this study mainly included whole-sale, retail and hospitality facilities.

According to the result of the regression study, there is not direct correlation between cargo capacity and volume of commercial land use. The correlation between the number of airport employees and the proportion of commercial land use around the airport is also not clear.

However, the proportion of commercial land use is closely related to the number of annual passengers in seven case study airports. According to Figure 3-13, the correlation between the number of airport passengers and the proportion of commercial land use is clear: The larger the number of annual passengers, the more commercial land use needs to be developed in the airport-surrounding region. The correlation between numbers is most evident in the scope of 9 km from the airport, and it could be used as a reference for further planning of commercial land use distribution in a scope of 9 km of a newly opened airport.

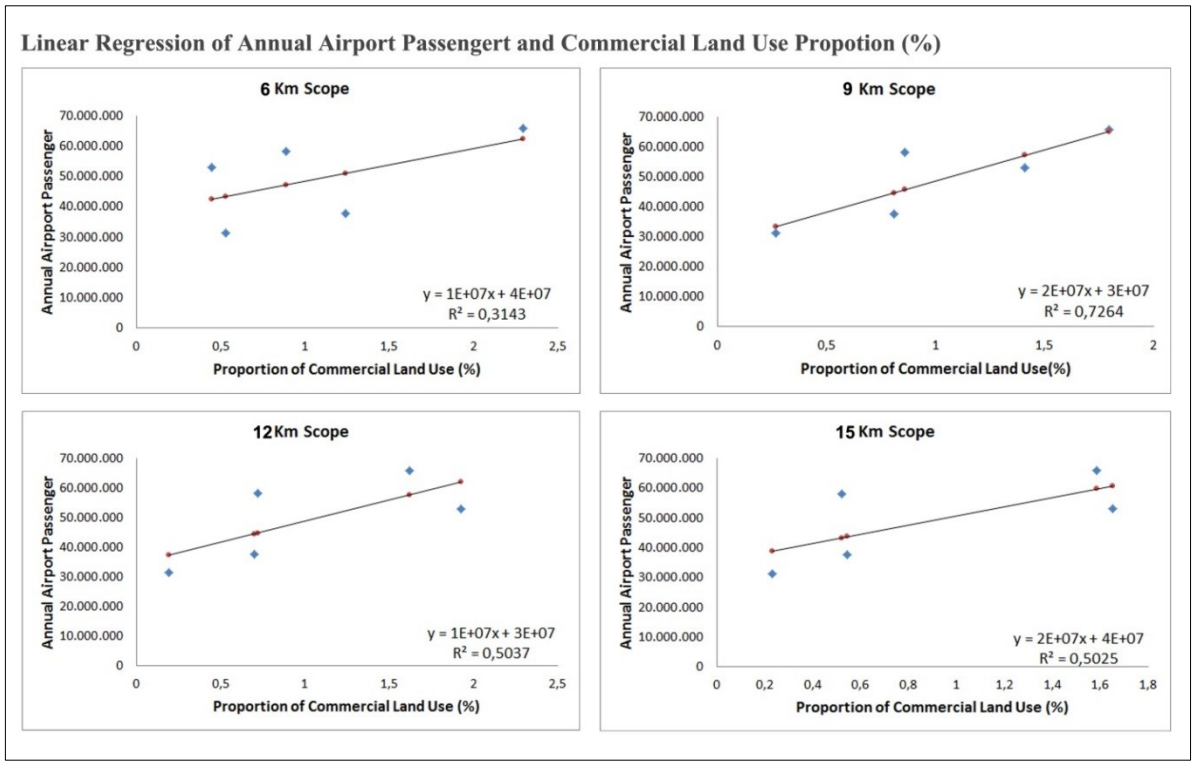

Figure 3-13Linear Regression of the Number of Annual Passengers and Commercial Land Use Proportion (%) within 6, 9, 12 and15-km Scope in Case Study Airport Regions
Source: By the author

Amsterdam Schiphol and Paris Orly Airport are considered outliers, as in these airports the commercial land use proportion is much higher than in the other five case study airports, as concerns their annual passenger number. The influencing factor that leads to a higher proportion of commercial land use of these outliers will be discussed in later sections.

■ Outliers

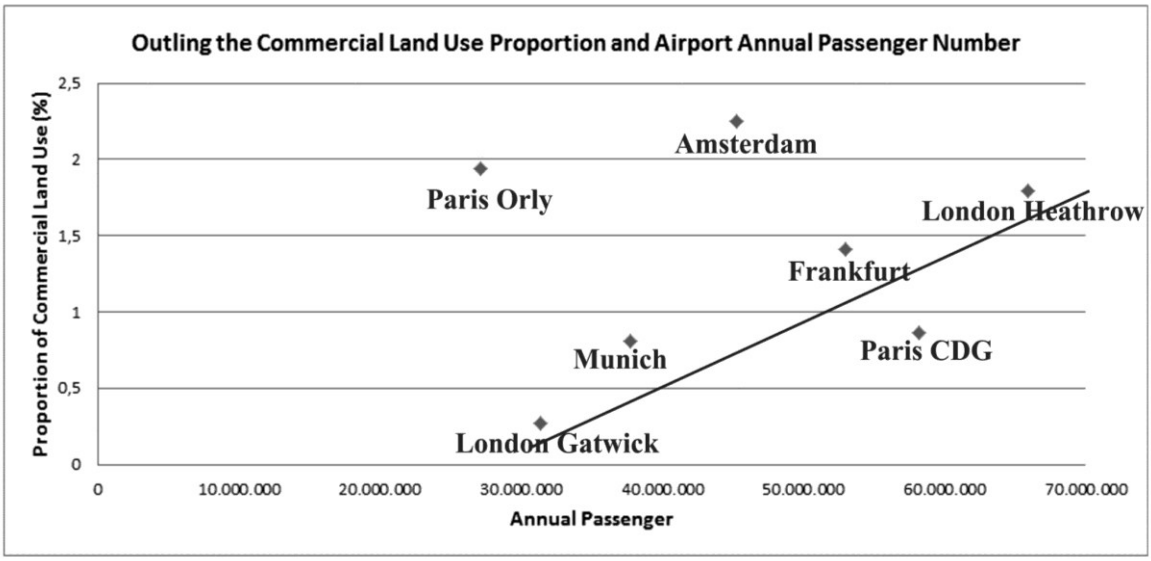

Figure 3-14 Regression Analysis of Commercial Land Use Proportion and Annual Passenger Number
Source: By the author

According to the resultant of the regression on the annual passenger number and the proportion of commercial land uses, the Paris Orly airport and the Amsterdam Schiphol airport have a much higher proportion of commercial land use in the surrounding urban region compared to the other five case study airports. Therefore, they are considered as outliers, and have certain specialties regarding their surrounding commercial land use development.

Joop Krul[59] (2011) summarized several factors for the commercial success of the Schiphol Airport, and these factors are also appropriate to explain the commercial success in the Orly Airport.

1. Connectivity: The importance of the network

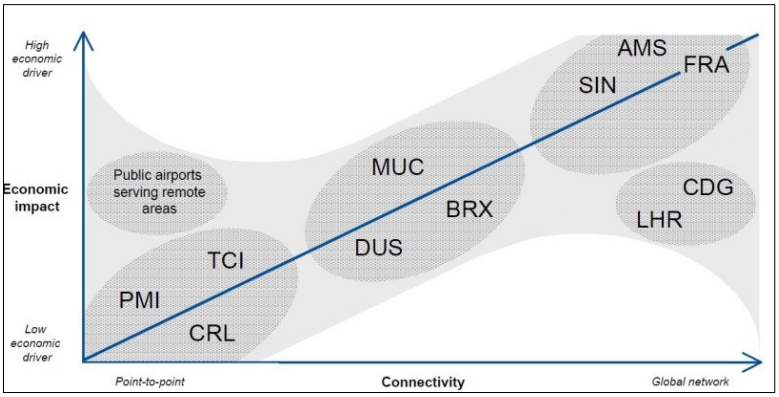

Figure 3-15 Connectivity and Airport Economic Impact on Airport Region
Source: Success Factors for the Airport City - the Case Schiphol, Joop Krul

According to Joop Krul, the network is the major asset of the airport city and the most important driver for the main port. The network of an airport includes not only its scheduled destinations, but

[59] Joop Krul, *Succes Factors for the Airport City- The Schiphol Case* (Amsterdam NL: Schiphol Group, February 2011)

also national and international road and railroad connections. Figure 3-15 shows an approximate linear correlation between airport connectivity and airport economic impact. From the figure we know that the higher the airport's connectivity level, the more economic impact it will bring about.

2. Competitive region and market place

It is no doubt that an airport is a competitive region and market place, and many businesses and companies in the Amsterdam region are dependent on air transport and a location near the airport.

Sector of Industry	Dependency Rate on Aviation
International Headquarters	98%
International Transport & Distribution	88%
Large International Enterprises	82%
4, 5 Star Hotels	75%
Business and Financial Service	46%
Technology Institutes	42%

Table 3-3 Industries' Rate of Dependency on Aviation
Source: By the author according to Regional Survey VNO/NCW (Confederation of Netherlands Industry and Employers) 2008

Amsterdam Schiphol is the earliest and the most efficient modern airport city model that transformed an airport into a successful economic center. In 1957, Amsterdam Airport Schiphol was the first airport on European mainland to have tax-free shops. Through the Schiphol Real Estate Group, Amsterdam Schiphol Airport has been involved for two decades in landside commercial development. These include office complexes, hotels, meeting and entertainment facilities, logistic parks, shopping and other commercial activities branded under the Airport City name. Nearly 58,000 people are employed at Schiphol, which integrates multimodal transportation, regional corporate headquarters, shopping, logistics and exhibition space to form a major economic growth pole for the Dutch economy[60].Therefore, for an international airport that aims to gain commercial success by itself and its surrounding urban region, it is necessary to actively engage in business development in the airport region, but not consider the airport as only an urban

[60] Rosário Macário, "Airports of the Future: Essentials for a Renewed Business Model," *European Journal of Transport and Infrastructure Research* 8, no. 2 (2008): 2.

infrastructure.

3. Clear strategy and business model

The principal objectives that the Schiphol Group has set itself were to create sustainable value for its stakeholders, to position the Amsterdam Airport Schiphol as the leading Airport City, and to rank among the world's leading airport companies. The strategy employed for achieving these objectives has three main elements: Maintaining and strengthening the competitive position of Amsterdam Airport Schiphol as a main port; increasing revenues from non-aviation activities; and diversifying risk by selectively developing activities at other airports at home and abroad[61]. This business model encompasses four business areas, which reinforce each other in the creation of growth and value at the Schiphol site and elsewhere, and play a key role in the implementation of this strategy, which aims at the integrated development of aviation and non-aviation activities[62].

Paris Orly airport enjoys a superior location, and its surrounding urbanism is on the highest level compared to other case study airports. Moreover, it stands at the crossroad of the major scientific centers in southern Paris. It is in the heart of the "Paris Biotech Valley", a network of expertise that ranges from the major hospital facilities, on Paris's left bank, through the Evry Genopole biotech park, to the cancer campus. It is also in close partnership with Plateau de Saclay, an area with large concentration of major European-quality facilities used by government and private researchers in all disciplines. Further, the Cancer Campus is a biocluster anchored at Europe's top cancer research and treatment center, with 60 hectares dedicated to innovative life science companies. The Paris Biotech Valley has 230 research laboratories, 4,000 researchers and engineers and 25,000 students. The Saclay has 34,000 students, 21 academic research labs and seven higher-education institutions.

Such location privileges work together with the Orly airport to ensure business success and regional competitiveness in the airport region. The large area of institutional land use and the airport are interactive with each other's expansion. The real estate market in airport-encircling areas suffering direct and indirect impact from large institutional land use has expanded to 1,000 acres of potential development land and 890,000 offices in later years[63].

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[61] *Schiphol Group Annual Report 2006* (The Netherlands: Schiphol Group, 2007), 11.

[62] *Schiphol Group Annual Report 2006* (The Netherlands: Schiphol Group, 2007), 11.

[63] "*Orly and Roissy Business Hubs - Aéroports de Paris,*" accessed September 27, 2013, http://www.aeroportsdeparis.fr/ADP/en-GB/Group/Sustainablegrowth/civil_society/orly_and_roissy_business_hubs/.

3.4 Airport Location as Influencing Factor on Land Use Distribution

According to results of density analysis of land use distribution using eight case study airports in six cities, land use distributions show different features effected by airport location and spatial relationship between airport and its connect city. Both airport location and its distance to the main city could be induced as three typologies: as an airport in the metropolitan region (city circle), one at the city edge, and one that is distant to the connected city. Frankfurt and Amsterdam Schiphol could be considered as airports located in the metropolitan region (city circle); in turn, London Heathrow, Paris Orly, Paris Charles de Gaulle and Zurich airports could be considered as being located at city edges. Further, London Gatwick and Munich International airports could be seen as distant to their connected cities. These spatial relationships between airports and respective main cities also determine to a certain extent the land use distributions and urban spatial development patterns.

3.4.1 Airport in City Circles

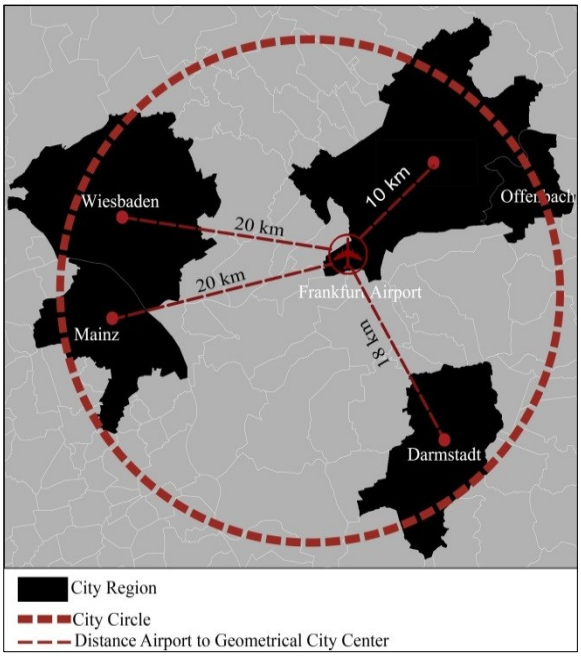

Figure 3-16 Spatial Relations of Frankfurt Airport and Connected Urban Regions
Source: By the author

Frankfurt and Amsterdam Schiphol airports could be considered as being located in metropolitan regions. Taking the Frankfurt airport as an example, it is not only at the edge of the city of Frankfurt, but it is also located in the geographical center of Frankfurt Rhine-Main region, which has the Frankfurt Airport as the one and only international airport. The metropolitan region has a total population of about 5.8 million. The metropolitan region is composed by the cities of Frankfurt am Main, Wiesbaden, Darmstadt and Mainz. The airport is located 18 km from Darmstadt, which has a population of

147,927 in the urban region and of 430,993 in its larger urban zone[64]. Darmstadt is prominent for its technology and research institutions, especially in aerospace fields; the European Space Operations Centre (ESOC) of the European Space Agency is located in Darmstadt. From here, various deep-space exploration spacecrafts and Earth-orbiting satellites are operated for the purposes of scientific research and technology development and demonstration. EUMETSAT, the European Organization for the Exploitation of Meteorological Satellites, operates the principal European meteorological satellites from its headquarters, including the first and second generations of Meteosat geostationary satellites. Darmstadt is also well known for its pharmaceutical and chemical industry, with Merck, Roehm and Schenck RoTec (part of The Duerr Group) having main plants and research centers here. Yet, Darmstadt has no airport with scheduled passenger services, with the historic role of such an airport having long been taken over by the nearby Frankfurt Airport.

The airport is 20 km away from the geometrical center of the city of Wiesbaden, which is the capital of the federal state of Hessen. It has a population of 280,000[65]. Wiesbaden hosts a number of international companies, which have their German or European headquarters here, for example CSC, Ferrari, Federal-Mogul, Melbourne IT, Norwegian Cruise Line and SCA. Several German companies also have their headquarters in Wiesbaden, including SGL Carbon, Dyckerhoff, Kion and DBV-Winterthur and R+V Versicherung. Wiesbaden is also home to the "Industriepark Kalle-Albert", an industrial park in the southern quarter of Biebrich. It is one of the largest in Germany, with over 80 companies from the pharmaceutical and chemical industry, including Agfa-Gevaert, Clariant, Mitsubishi Chemical Corporation and Shin-Etsu Chemical. The park was founded by the chemical company Hoechst AG in 1997. With approximately €77,500, Wiesbaden has the second largest gross domestic product (GDP) per inhabitant in Hessen, after Frankfurt, making it one of the richest cities in Germany[66].

The airport is also 20 km away from the geometrical center of the city of Mainz, which is the capital of the federal state of Rhineland-Palatinate. The population in early 2012 was of 200,957; an additional 18,619 people maintain a primary residence elsewhere but have a

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[64] *Die Bevölkerung Der Hessischen Gemeinden*, Statistische Berichte (Hessisches Statistisches Landesamt, December 2012).

[65] *Die Bevölkerung Der Hessischen Gemeinden*, Statistische Berichte (Hessisches Statistisches Landesamt, December 2012).

[66] *Wiesbadener Stadtanalysen* (Amt für Strategische Steuerung, Stadtforschung und Statistik, March 2013).

second home in Mainz. Mainz is one of the centers of the German wine economy. The Mainzer Weinmarkt (wine market) is one of the greatest wine fairs in Germany. Since 2008, the city is also a member of the Great Wine Capitals Global Network (GWC), an association of well-known wine-culture cities of the world[67]. The Schott AG, one of the world's largest glass manufacturers, as well as the Werner & Mertz, a large chemical factory, have a home in Mainz. Other companies such as IBM, QUINN Plastics or Novo Nordisk have their German administration in Mainz as well.

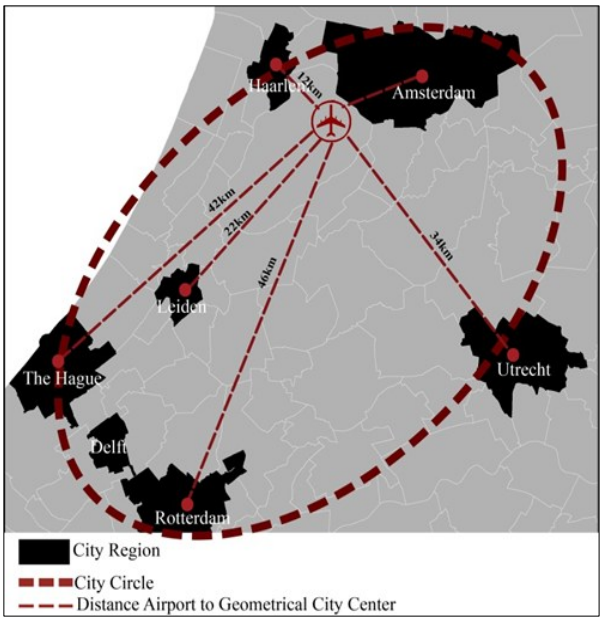

Figure 3-17 Spatial Relations of Amsterdam Schiphol Airport and Connected Urban Regions
Source: By the author

Amsterdam Schiphol has a situation similar to the Frankfurt airport. Except for Rotterdam with the Hague Airport, which runs seven airlines and had a limit capacity of 1,146,692 passengers in 2010, Schiphol is one and the only international airport that serves not only the Amsterdam Metropolitan region, but also many large to mid-sized cities in the south of the Netherlands, such as Utrecht, Leiden, Delft, the Hague and Rotterdam. The city of Utrecht is 34 km away from the airport, with a population of 323,617 in 2013, and is famous for its commercial and educational facilities; Leiden, at 22 km from Schiphol, houses the Eurotransplant, the international organization responsible for the mediation and allocation of organ donation procedures. Leiden also houses the headquarters of the European Aeronautic Defense and Space Company, a global pan-European aerospace and defense corporation. The group includes Airbus, the leading manufacturer of commercial aircrafts worldwide.

When international airports are located in the city circle and serve not only its main connected city, but also the whole city circle, the airport impact region cannot be defined just by the communities between traffic linkages from the airport to the main city, but rather as the whole city circle. In other words, unlike airports located at the city edge or at a distance to its connected city, those located in the city circle have a wider impact range and lead to revitalizations in all communities in the city circle scopes, especially along

[67] Mainz Magazin, Mainz City Council, Accessed 07.accessed Oct. 2013, www.mainz.de

ground traffic networks between each city.

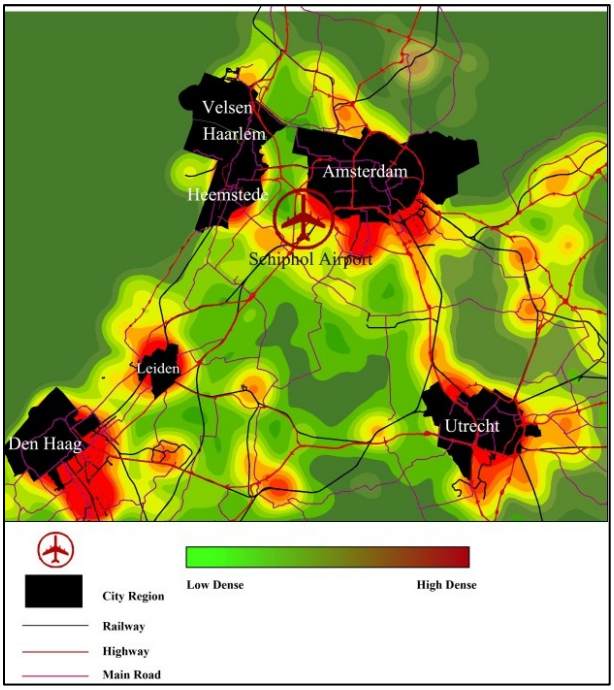

Figure 3-18 Density Analysis of Commercial and Industrial Land Use Clusters in Amsterdam Airport Region
Source: By the author

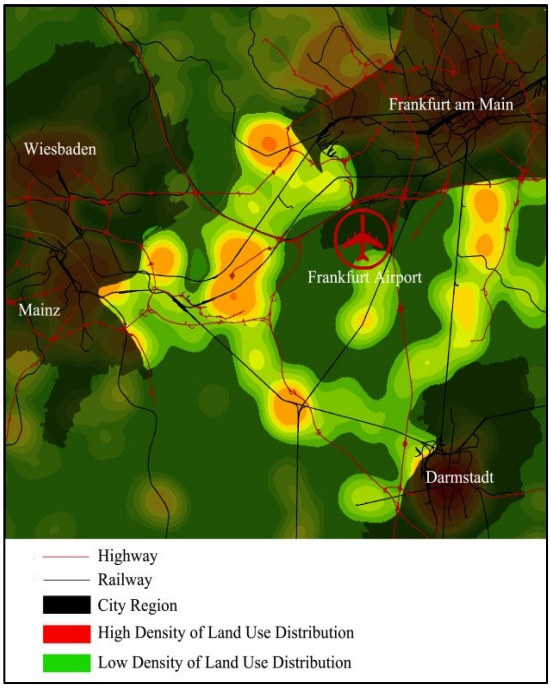

Figure 3-19Density Analysis of Commercial and Industrial Land Use Clusters in Frankfurt Airport Region
Source: By the author

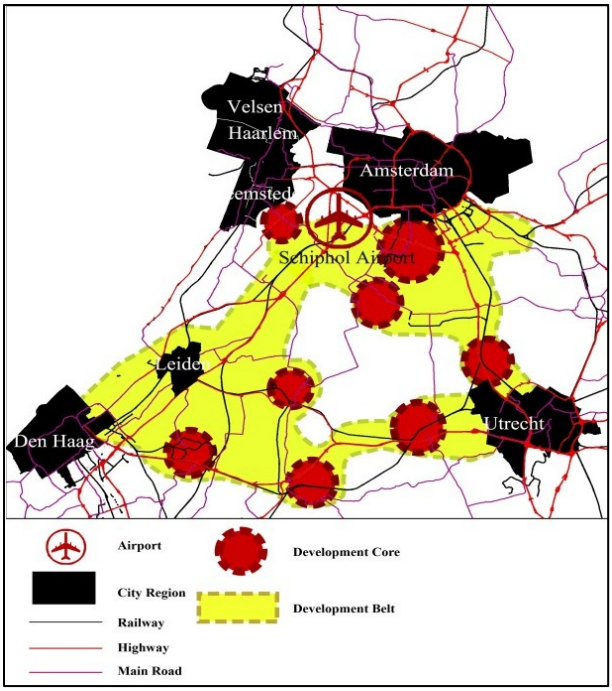

Figure 3-20 Development Hot Spots and Belts in Amsterdam Schiphol Airport Region
Source: By the author

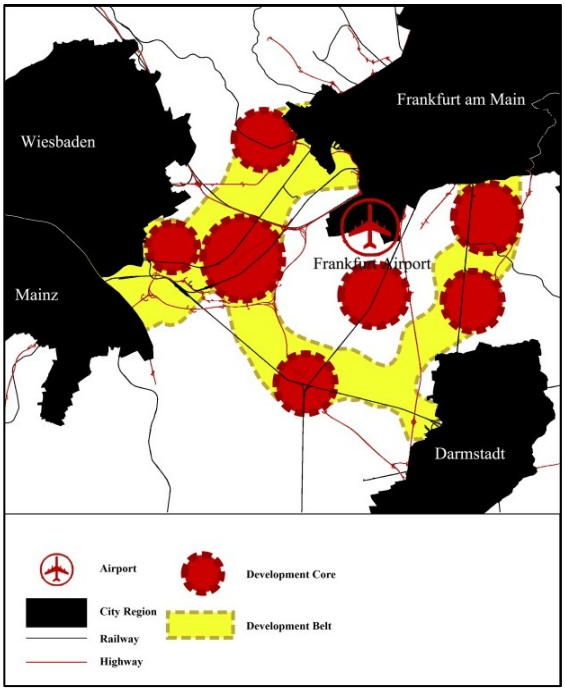

Figure 3-21 Development Hot Spots and Belts in Frankfurt Airport Region
Source: By the author

Figure 3-18 and Figure 3-19 are GIS density analyses of commercial and industrial land uses within the Frankfurt Rhine-Main and the Amsterdam metropolitan regions. Figures 3-20 and 3-21 show the development cores, belts with high-density industrial and

commercial land uses. According to the four figures above, nearly all communities (*Gemeinden* in German) are more or less impacted by airports and all communities that show very clear airport-related economic structure. Community or town centers in city circles are shown as development hot spots with very high frequency of urban developments. Traffic linkages between not only airports to cities, but also each city in the whole urban circles are shown as development belts with high density of land use distribution, thus forming a high-density development "ring" enclosing the airport.

One more example for airport impacts on land use clusters in airport regions, according to Figure 4-18, is that there is not even a direct railway and highway connection between the Amsterdam Schiphol Airport and the city of Utrecht. Although there is only a state road linking both, urbanism is still present along the state road, and the municipalities of Aalsmeer, Uithoorn and De Ronde Venen, lying alongside the state road, show evident airport-related commercial/industrial land use development under the impact of the airport.

Figure 3-22 Industrial and Business Region in the community of de Ronde Venen
Source: google map (www.google.de)

An example is the community of De Ronde Venen (Figure 3-22), located 12 km from the Schiphol Airport, 5 km to the city border of Amsterdam and 23 km to the city of Utrecht. There is no railway and motorway connection, but only a state road connection passes through this locality, even though it has still developed as an aero-industry-based community. The locality has a population of only 34,589, but contains a large industrial and business area of nearly 395 hectares housing mainly high-tech manufactures and logistic industries, which are closely related to airports. This example could strongly support that, when an airport is located within a city circle, urban clusters may happen not

only along the railway or highway, but also between communities located between main roads.

From the above figures we can conclude that airports located in city circles and serving more than one large-sized city will have a broader impact range than ones that serve solely the connected city. When an airport is developed not only for its connected city, but for a city circle or a development region, it may bring a greater impact range than one serving only its respective main city. Moreover, the urbanism of original town or community centers adjacent to traffic belts that lie between the city circles will be impacted by aero-base industries and became the new development hot spots.

3.4.2 Airport Location's Distance to the City

Figure 3-23 Location of London Gatwick Airport
Source: By the author

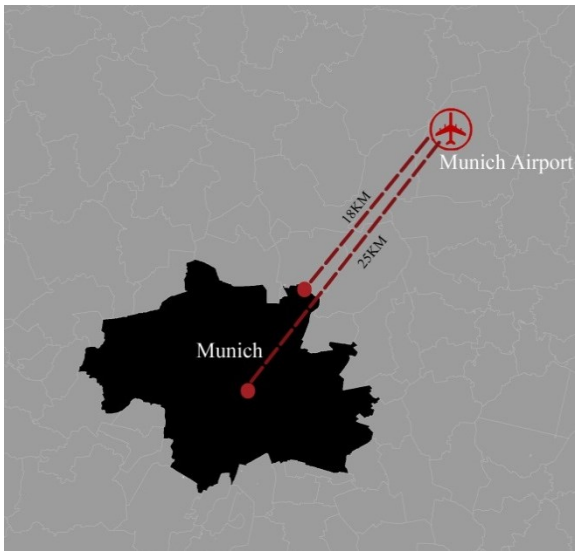

Figure 3-24 Location of Munich Airport
Source: By the author

As for the typology of airports distant to their connected main cities, London Gatwick (18 km to the city border and 40 km to London's geometric center) and Munich International Airport (18 km to the city border and 25 km to Munich's geometric center) could be good examples.

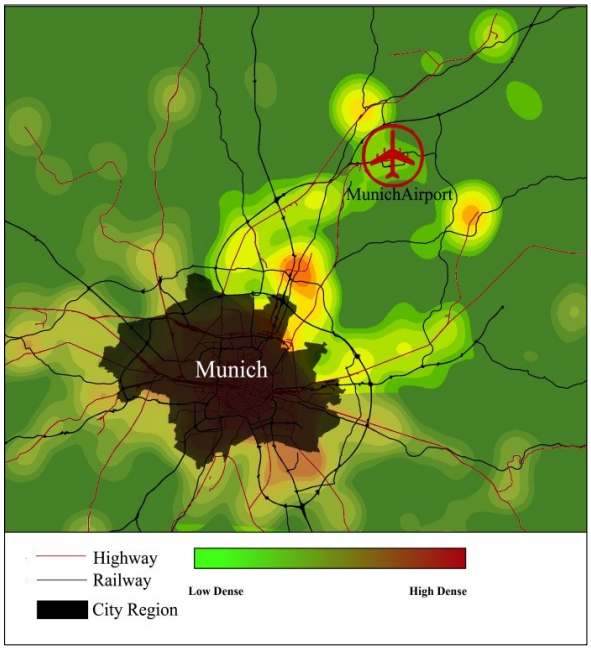

Figure 3-25 Density Analysis of Industrial and Commercial Land Use Distribution in Munich Airport Region
Source: By the author

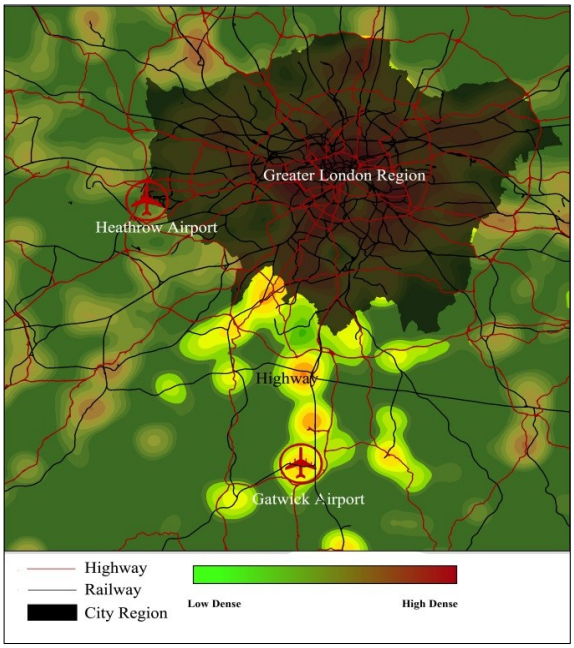

Figure 3-26 Density Analysis of Industrial and Commercial Land Use Distribution in London Gatwick Airport Region
Source: By the author

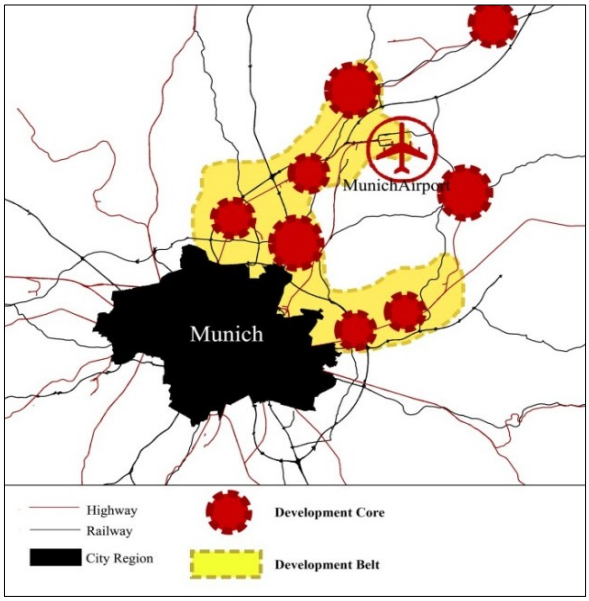

Figure 3-27 Development Hot Spots and Belts in Munich Airport Region
Source: By the author

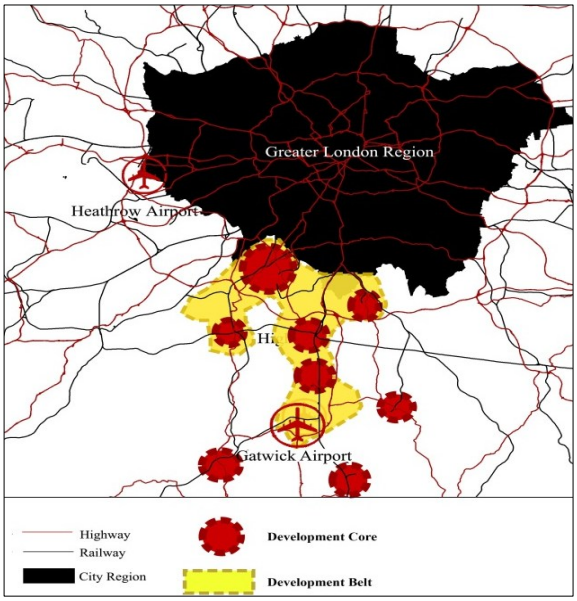

Figure 3-28 Development Hot Spots and Belts in Gatwick Airport Region
Source: By the author

Figure 3-25 and Figure 3-26 show the density of industrial and commercial land use distribution impacted by the Gatwick and Munich International airports. Figures 3-27 and 3-28 show the urbanism cores and development belts formed around these two airports. Several features of land use distribution can be concluded from the above four figures.

■ Urban Development at the Airport Itself and Its Surroundings

In this typology, an airport is located at a certain distance to its connected city, but not directly at its edge. Compared to the other two typologies, the airport itself has more attractions to industries directly airport-related, as well as for development of all kinds of land uses.

For an airport that has a certain distance to its connected city, because the traveling time is longer than for those located at the edge of the main city, hospitality facilities serve airport passengers and staff; residential facilities serve airport staff; and headquarters, business parks, industrial areas that have a closer relationship to the airport may mainly clusters around the airport or at localities adjacent to it. Communities that encircle this kind of airport show more prominent airport-related economic structure, and with extremely high density of airport-related land use – in other words, they constitute aerotropolises, urban plans in which the layout, infrastructure and economy are centered on the airport, existing as an airport city. They are similar in form and function to a traditional metropolis, which contains a central city core and commuter-linked suburbs, being commonly formed at airports that have a certain distance to the respective main cities[68].

In Gatwick Diamond, companies have more convenient access to the airport, as well as to excellent market opportunities, world-class skills and a highly supportive and open business environment. The Gatwick Diamond has one of the strongest local economies in the UK, lying just minutes from central London, with London Gatwick Airport at its heart, and one hour away from Heathrow Airport. An outstanding interconnected infrastructure of air, road, rail and sea transport connects the Gatwick Diamond to London and the rest of UK, mainland Europe and the rest of the world. Currently, Gatwick Diamond houses a total of 45,000 businesses and 500 international ones, and offers access to excellent

Figure 3-29 Gatwick Airport with Aerotropolis Urbanism Features
Source: The Gatwick Diamond Initiative, www.gatwickdiamond.co.uk

[68] John D. Kasarda, "Airport Cities and the Aerotropolis: The Way Forward," *Global Airport Cities, London Insight Media*, 2006, 21,

connectivity, talented labor force, strategic location and developed supply chain. There are six industry sectors which are particularly strong. They are: aviation, aerospace and defense; advanced manufacturing and engineering; financial and professional services; life sciences, health technologies and medical devices; environmental technologies; and foods and beverages.[69]

■ Urban Development Along Traffic Corridors

Compared to the other two typologies, a more obvious feature here is that an urbanization corridor has been formed along the traffic linkage between airports and their connected cities. Taking Munich airport as an example, there are two urbanism corridors between the airport and the city of Munich. The first corridors start at the community of Oberding, where the Munich International Airport is located, and ends at the Community of Oberschleissheim. Localities like Neufahrn, Eching and Unterschleissheim that lie along the highway (A92) and railway connection (S1) have a total population of 58,039, according to the statistics of 2013, but share a large industrial and business region of about 176 hectors, which shows obvious airport-related urban development.

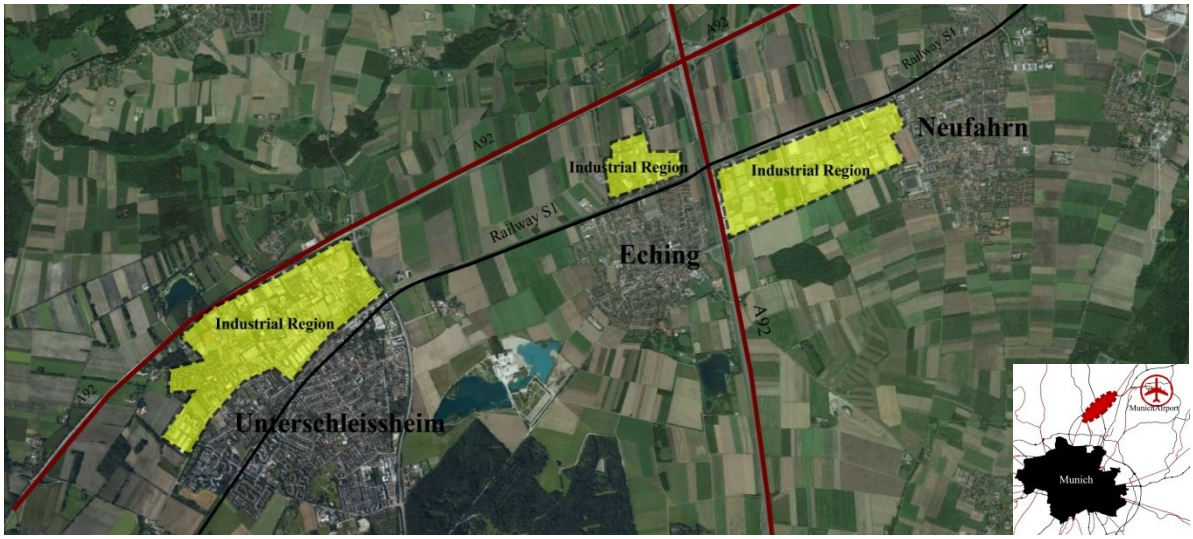

Figure 3-30 Development Belt Between Munich Airport and the City of Munich
Source: Google map, www.google.de

■ Business and Industrial Parks Located Opposite to the City Direction

Unlike the common understanding of land use distribution surrounding the airport, the urban development around an airport that is distant to its connected city may form not only along the corridor between the airport and its connected main city, but also appear at some

[69] Colin Drinkwater, "Gatwick Diamond Initiative," February 4, 2014, http://www.westsussex.gov.uk/your_council/plans_projects_reports_and/initiatives/gatwick_diamond.aspx.

communities in the opposite airport-city direction. This situation was seen in both Munich and Gatwick airports.

Yet, unlike urbanism along traffic corridors from airports to respective cities, urbanism in the opposite direction to cities has a more obvious image of industry and business development, and the progress is mostly led by aero-related industries such as business parks and industrial estates, and with few residential units. This means that such areas constitute mainly work places rather than living space, and advanced public transportation is needed for daily commuters. These communities are developed as an industrial park with necessary service facilities, rather than a city with complete urban function.

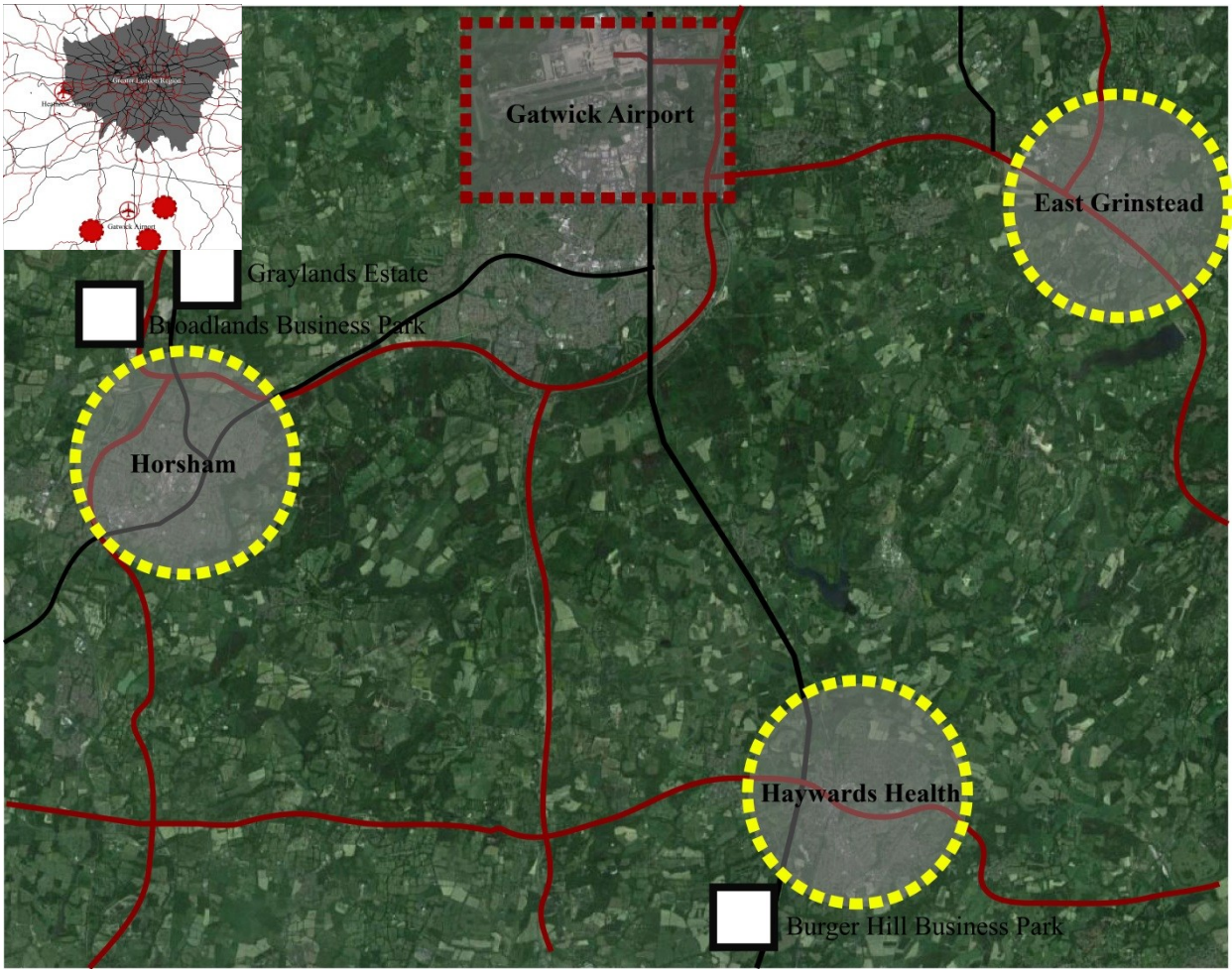

Figure 3-31 Airport Impact on Urbanization of Reverse Direction to City at Gatwick Airport-surrounding Communities
Source: Google map, www.google.de

Taking the Gatwick Airport surroundings as an example, three communities located at the opposite direction to central London and along the traffic corridors have been impacted by the airport, and present high attraction for industrial and commercial development.

Burgess Hill Business Park is a large-sized business park developed at the south of Haywards Health. It is the second largest business park in the Gatwick Diamond, with about

300 companies employing 8,000 people in over 1.8 million sq. ft of premises. Burgess Hill Business Park is home to a variety of businesses from Icon Live, which manufactures licensed products for the London 2012 Olympics, to HPC precision engineering, which produces parts for some of the most iconic British motor cars; and from CAE (Aviation Training and Flight Simulators) to the UK HQ of Roche (Swiss), the leading pharmaceutical and in-vitro diagnostics healthcare company[70].

Graylands was originally the country estate of Boyd Wallis, partial owner of Kimberley Diamond Mines. Subsequently, Graylands was owned by Redland Bricks, which established their UK headquarters there and added the many and varied buildings that make up the estate as it exists today. It is an attractively restored collection of offices and workshops in a parkland setting[71].

Several points could be concluded from the land use distribution features, such as:

1.) Airports not only impact in the direction of their connected cities, but also have strong influence on localities in the opposite direction.
2.) Prerequisite for communities located at the opposite direction of the airport-city corridor to be transformed into air-front communities is that they must have superior traffic network to their respective main city and the airport.
3.) These communities are located in the opposite direction of the city, and the distance between localities is larger than between those near urban borders. Therefore, distribution of these communities is commonly shown as point-shape rather than planar-shape distribution, with large areas of agricultural land use or nature preservation land in between.

3.4.3 Airport at City Edge

The three figures below are density maps of the distribution of urban facilities in the cities of Zurich, Paris and London. Except for London Gatwick, the other four airports are of the same typology – located at the edge of their connected main cities.

[70] Official website of Gatwick Diamond Initiative, accessed on 26 July 2013, www.gatwickdiamond.co.uk

[71] http://www.graylandsestate.co.uk, accessed on 10 May 2013

■ Airport Impact Integrated Within Urban Development in City Region

When an airport is located directly at the edge of its connected city, because of the shorter traveling time from the airport to the city, noise-sensitive service facilities such as hospitality, residential units and business parks for housing headquarters are not necessarily located in the airport noise contour. Thus, in the direction from the airport to its connected city, although the airport has strong impacts on its surrounding region, the cluster effect of housing and hospitality in this direction is not as obvious as airports that lie at a distance to the city. When an airport is situated at the edge of its connected city, it may be considered as a part of a city with a planar-shape land use distribution with mainly industrial facilities, rather than as a new urban development core separated from its adjoining city.

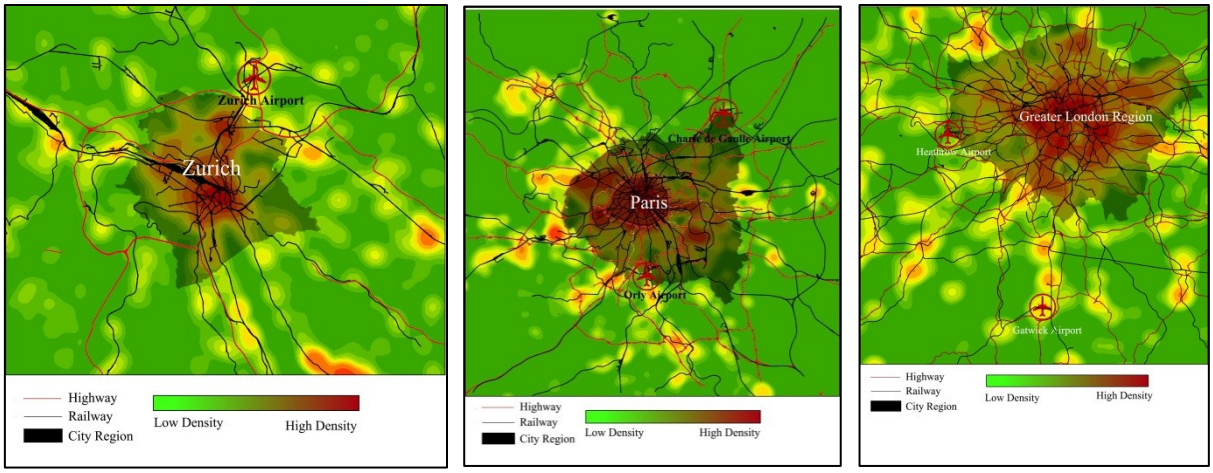

Figure 3-32 Density of Urban Facilities Distribution in the Cities of Zurich, Paris and London
Source: By the author

According to Figure 3-32, unlike cluster cores formed at airports that have a certain distance to their main cities, urban regions close to airports located at the edge of a city show lower land use density for all urban functions, and form a buffer region between airport and city center, with lower land use distribution density than the average of the urban region. These figures also prove that when an airport is located at the edge of the city, because of its superior accessibility to the whole urban region, it will have a positive impact on industrial and business clusters, but a negative one on residential clusters, which form a large-sized thematic development zone between airport and city.

Although airports situated at city edges have more negative cluster impacts than in the airport-city direction, they have positive effects along the traffic networks in the contrary direction. The Figure 3-33 shows obvious urban clusters from the Orly Airport to its south and from the Heathrow airport to its west, as a linear-shape expansion of those

metropolises led by airport impact. As in the opposite direction from the airport to the city the large size of the land for further development makes it more available than in the city, and because of its lower land price and same superior accessibility, the large-sized, thematic urban development appears at the edge of the city along traffic corridors.

3.5 Ground Traffic and Airport Noise Impact on Land Use Distribution

3.5.1 Importance of Ground Traffic in the Airport Region

When airports are considered as the heart of the city, ground traffic networks are like blood vessels that link the airport to its region. If transport connections allow the movement of people and goods further and faster, they essentially increase the airport catchment area. This may have significant environmental impacts at both local and regional levels, including the availability and value of land.

In fact, ground traffic linkage plays a vital role in determining the impact on land use variation and land value changes in communities of the airport periphery region. When considering the noise impact from the airport, there are certain urban facilities that could not directly get established close to the airport. Therefore, localities that have certain distance and with superior traffic connections may enjoy better development opportunities than those near the airport. In other words, accessibility plays a more important role than distance to the airport for changing localities' urban image and land values.

First, airport-related economies are considered as time-based. Time efficiency is significant in delivering air freights. Moreover, convenient and faster ground access from an airport to its surrounding region is not only important for air passengers, but also significant for employees working in airports and firms in these regions and short-time users (tourists, visitors, clients, etc.). Therefore, ground access is an important condition in judging the quality of work/living space, and also has great impacts on real estate markets and land value. Thus, not only the interchanging terminals of airports, but also nearby railway stations and highway joints between airport and cities are important preconditions for urban revitalization of airport-surrounding communities.

Second, according to the tendency of airport region formation, a large number of companies and industries are and will be located in the airport region; thus, more and more

employees will work in the area and share the ground traffic access from the city to the airport with increasing airport passengers. Therefore, road and highway access to the

Airports are increasingly discriminated due to congestions and capacity bottlenecks in the airport region. In fact, since airports are increasingly enmeshed in larger urban areas, the mention of road congestions could be found in reports of all large international airports. This way, sufficient ground access from the city to the airport region plays an important role in maintaining the wellness of airport operations and access advantages of its region, as ground traffic congestion is a common problem that may hinder the development of the airport region.

Third, the airport does not provide transit from landside to air traffic. Transfers between the different landsides become ever more attractive in airport hubs, as the networks of high-speed trains, national railways or coaches and of local and regional public transportation converge at the airport. These opportunities have made the airport the second main railway station of the regions of Zurich, Amsterdam and Frankfurt and many other large international airports[72].

Therefore, in evaluating the successfulness of an airport development, the airport itself should not be the one and only determinate. Ground traffic plays even a more significant role in promoting local economy development in airport regions. The significance of ground traffic access to the airport should not be underestimated, and it is urgent for regional authorities to understand the major urban potential around the ground transportation networks.

3.5.2 Comparison of Railway and Highway Impact in Airport Region

Highway and Railway are two of the most important types of access from the city to airports. Due to their own characteristics, railway and highway impacts on the adjacent region occur in different ways. These differences, no matter whether negative or positive, will greatly change the urban spatial structure of their nearby area. Thus, an investigation of characteristic differences between railway and highway transportation could be a significant precondition for their adjacent communities when drawing further urban spatial development strategies.

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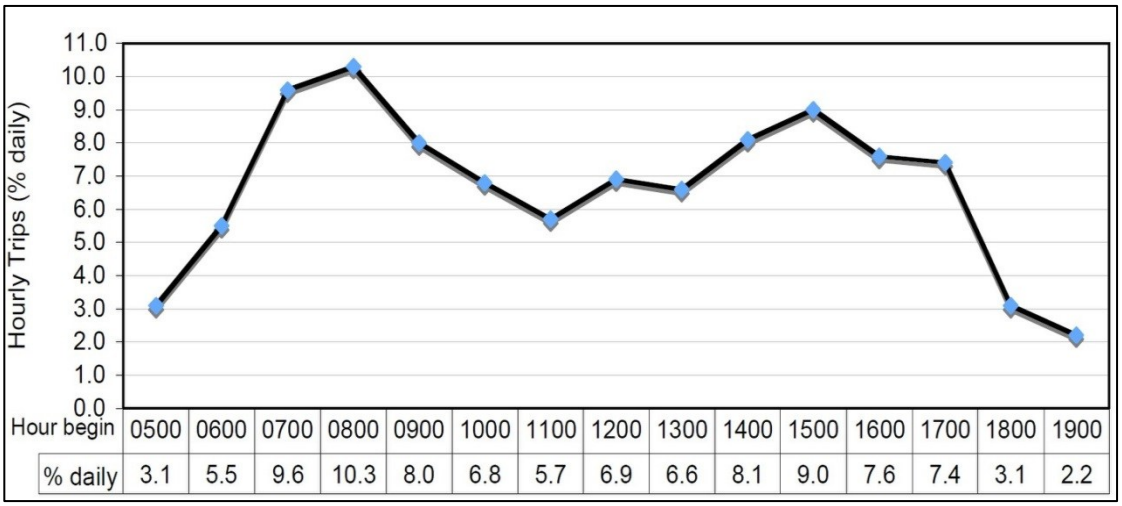
[72] Mathis Gueller and Michael Gueller, *From Airport to Airport City* (Barcelona: Gustavo Gili, 2003), 48.

■ On-Time Performance and Flexibility

According to Luis Ferreira, Nicholas Stevens and Doug Baker[73], reliability of travel is a critical factor in selecting the mode of transport. There is evidence that unexpected delay should be valued significantly differently from average travel time evaluations.

Figure 3-33 shows statistics by Luis Ferreira, Nicholas Stevens and Doug Baker[74] about the hourly distribution of rail passengers' trips from Brisbane city to Brisbane airport. According to the above figure, the daily peak periods of rail passengers' access to/from Brisbane airport coincides with the general peak period for the urban road and transit networks. Therefore, for passengers from/to airports, the scheduled rail trips are more reliable compared to automobile-based personal trips, which may be delayed by traffic congestion and other unpredictable reasons.



Hour begin	0500	0600	0700	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900
% daily	3.1	5.5	9.6	10.3	8.0	6.8	5.7	6.9	6.6	8.1	9.0	7.6	7.4	3.1	2.2

Figure 3-33Hourly Distribution of Rail Passenger Trips to Brisbane Airport
Source: The New Airport and Its Urban Region: Evaluating Transport Linkages, Luis Ferreira, 2006

For passengers, car travel is more flexible. Should a meeting end early, a commuter who traveled by car can leave immediately, whereas the departure of a high-speed rail commuter would depend on the train schedule. Automobile travel also allows for trip changes. For example, a car commuter can stop at other destinations along the way, either as planned or spontaneously. Car travels are also flexible because additional passengers can be added at no additional cost.

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[73] Luis Ferreira, Nick J. Stevens, and Doug C. Baker, "The New Airport and Its Urban Region: Evaluating Transport Linkages," in *Faculty of Built Environment and Engineering* (presented at the International Conference of Transport and Traffic Studies, X'ian: ASCE, 2006)

[74]Luis Ferreira, Nick J. Stevens, and Doug C. Baker, "The New Airport and Its Urban Region: Evaluating Transport Linkages," in *Faculty of Built Environment and Engineering* (presented at the International Conference of Transport and Traffic Studies, X'ian: ASCE, 2006)

For freight shipment, even rail freight transport can be more efficient and productive, but shipment by rail is not as flexible as via highway, which has resulted in much freight being hauled by truck, even over long distances. Freight shipment by truck is more flexible in places of dispatch and destination. Freight truck shipment could provide a door-to-door service to receiver and consigner. Besides, freight truck shipment is also more time-independent: It requires less operation time of loading, and is able to dispatch whenever the consigner requires. Therefore, many firms, like Parcelforce, FedEx and R+L Carriers, transport all types of cargo via roads. Delivering everything from letters over houses to cargo containers, these firms offer fast, sometimes same-day delivery.

Considering that airport-related logistics are more time-defined, the cargo delivery from/to airports is more reliable by freight truck than freight train shipment. Therefore, the airport logistic center is commonly located around highway joints, and communities located near these joints might have more opportunities than those situated along railways to attract investments for directly airport-related manufactures and logistics. However, airports are no longer considered just as a traffic infrastructure, but also as engines for urban development and attracting airport-related industries, and localities along cargo railways may as well suffer indirect impacts from the airport and attract industries more related with rail freight shipment models.

- **Air Pollution and Green Gas Emission**

When comparing ground traffic impacts on nearby urban development, the air-pollution caused by traffic models must be considered. The fine particulate matter and other harmful emissions from various transportation models cause not only physical discomfort and respiratory diseases for residents of areas around traffic corridors, but also large variation of external cost to traffic operators.

Mode	Estimated tons of PM2.5 emissions	Estimated tons of NOx emissions	Estimated tons of PM2.5 per million ton-miles	Estimated tons of NOx per million ton-miles
Trucks	229,754	5,824,060	0,1191	3,0193
Locomotives	3,520	141,865	0,0116	0,4691

Table 3-4 Estimating Tons of Freight-Related PM2.5 and NOX Emissions in 2002
Source: GAO Analysis of EPA and Texas Transportation Institute Data

Based on the literature study, the road network causes many times more air pollution than railways, and generates 40% of the total Nitrogen Oxides (NOx) and 34% of Carbon Monoxide (CO) in 27 member states of the European Union.

Medical research papers have also proved that long-term exposure to traffic-related air pollution is detrimental to health. The more close to the highway corridor, the more harmful its impact on human health. Therefore, air pollution from traffic should serve as a determinant for locating certain urban facilities, such as residential or educational units for teenagers and children.

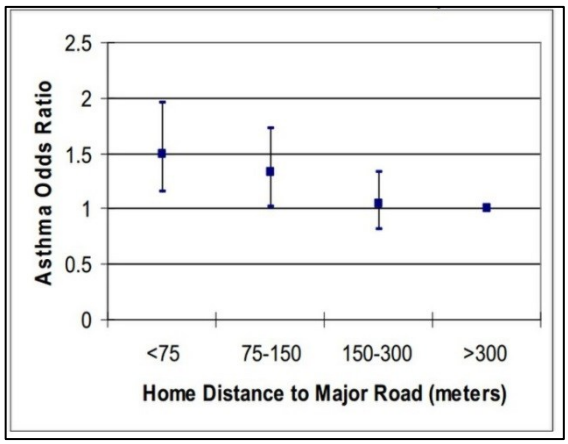


Figure 3-34 Lung Function Growth and Distance to Freeway
Source: Traffic, Air Pollution and Health, Frank Gilliland

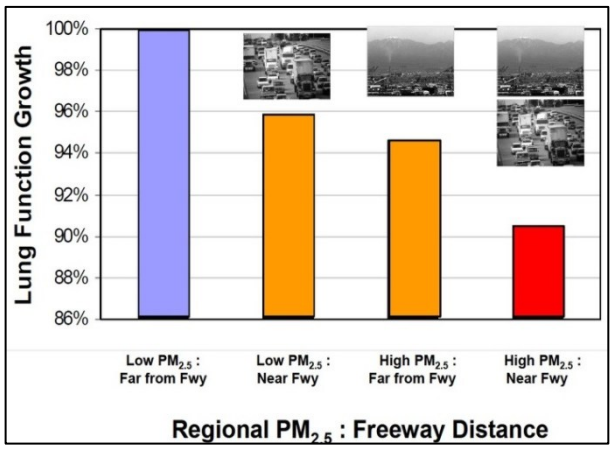


Figure 3-35 Traffic and Asthma - USC Children's Health Study
Source: Traffic, Air Pollution and Health, Frank Gilliland

■ Operation Costs of Rail and Highway

For freight shipment, cost is a critical consideration when selecting one mode over another. As the transportation carrier industry has been de-regulated, there is no accurate way to compare shipping costs of the various modes. Shipping costs are based on a wide range of factors including negotiated contract rates, volume of shipment, ultimate destination of shipment, discounts for backhaul, and use of a certain supply chain. Operating costs, however, can provide a general appreciation for what shipping costs might be[75].

Railroads generate lower operating costs per ton or costs per mile for large shipments than do trucks, because each long train carries the equivalent volume of 300-400 large trucks (300 trucks can move roughly the same number of containers as one train; some trains carrying bulk cargo can move as many as 400 trucks, and do so with fewer staff and handling costs). This is the case whether the shipment is long-distance or a short haul. The opposite is true for small shipments, in which trucks have lower operating costs per ton and per mile because the

[75] *Feasibility of Diverting Truck Freight to Rail in the Columbia River Corridor* (Technical Memorandum by Columbia River Crossing Project, April 2006), 21.

initial operating costs of a train are so high (see Tables 3-5 and 3-6)[76].

	50 Ton Load		10,000 Ton Load	
	By Truck	By Rail	By Truck	By Rail
Operating cost/hour	$82	$1,000	$82	$1,000
Travel time/trip	36 hours	48 hours	36 hours	48 hours
Number of trips	1	1	200	1
Direct operating cost	$2,952	$48,000	$590,400	$48,000
Cost of drayage in rail	$0	$82	0	$16,400
Total operating cost	$2,952	$48,082	$590,400	$64,400
Operating cost/mile	$1.48	$24.04	$295.20	$32.20

Table 3-5 Estimated Rail and Truck Operating Costs between Portland/Vancouver Region and Chicago (assumed 2,000 miles)
Source: Feasibility of Diverting Truck Freight to Rail in the Columbia River Corridor, Technical Memorandum Prepared by Columbia River Crossing Project, April 2006

	50 Ton Load		10,000 Ton Load	
	By Truck	By Rail	By Truck	By Rail
Operating cost/hour	$82	$1,000	$82	$1,000
Travel time/trip	2 hours	4 hours	2 hours	4 hours
Number of trips	1	1	200	1
Direct operating cost	$164	$4,000	$32,800	$4,000
Cost of drayage in rail	$0	$82	0	$16,400
Total operating cost	$164	$4,082	$32,800	$20,400
Operating cost/mile	$2.19	$54.43	$437.33	$272.00

Table 3-6 Estimated Rail and Truck Operating Costs between Portland/Vancouver Region and Chicago (assumed 75 miles)
Source: Feasibility of Diverting Truck Freight to Rail in the Columbia River Corridor, Technical Memorandum Prepared by Columbia River Crossing Project, April 2006

According to the two tables above, although the railway transportation model has advantages with regards to large shipment and long-haul transportation, the truck variant has advantages in short-haul and small shipment transportation. Considering that logistics and manufacture industry are commonly high-tech, high value-added and smaller-size products, truck model (highway access) have an irreplaceable position in the logistics industry. Highway joints should also be considered as an important determinant for locating logistic terminals or airport-related manufactures.

Except for shipping costs, the external costs of railway and truck freight are also important

[76] *Feasibility of Diverting Truck Freight to Rail in the Columbia River Corridor* (Technical Memorandum by Columbia River Crossing Project, April 2006), 28.

determinants that impact on the attractiveness for locating new industries or logistics around the airport. Statistics show the external costs of transportation, such as for air pollution, accidents, greenhouse gases, noise, etc. Here, the rail freight transportation has more advantages than the highway.

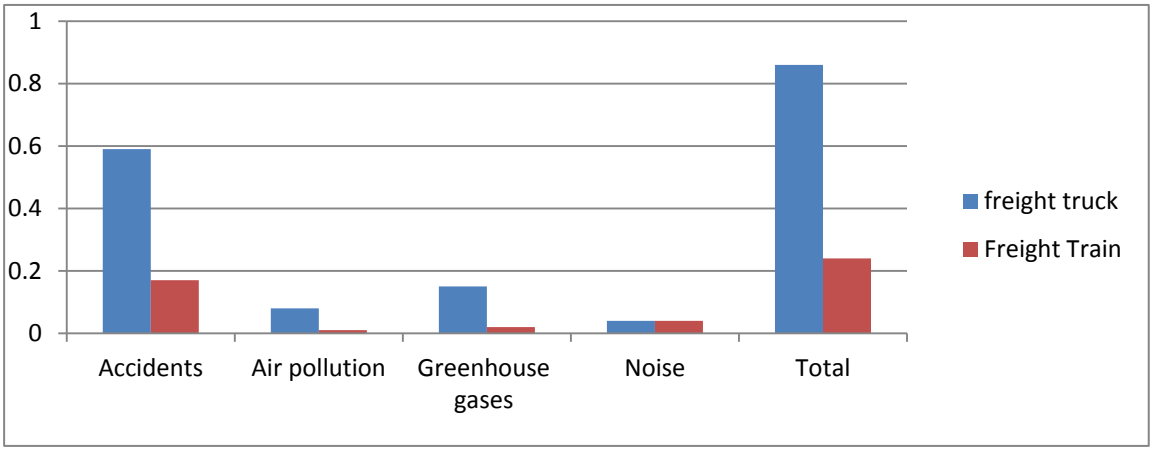
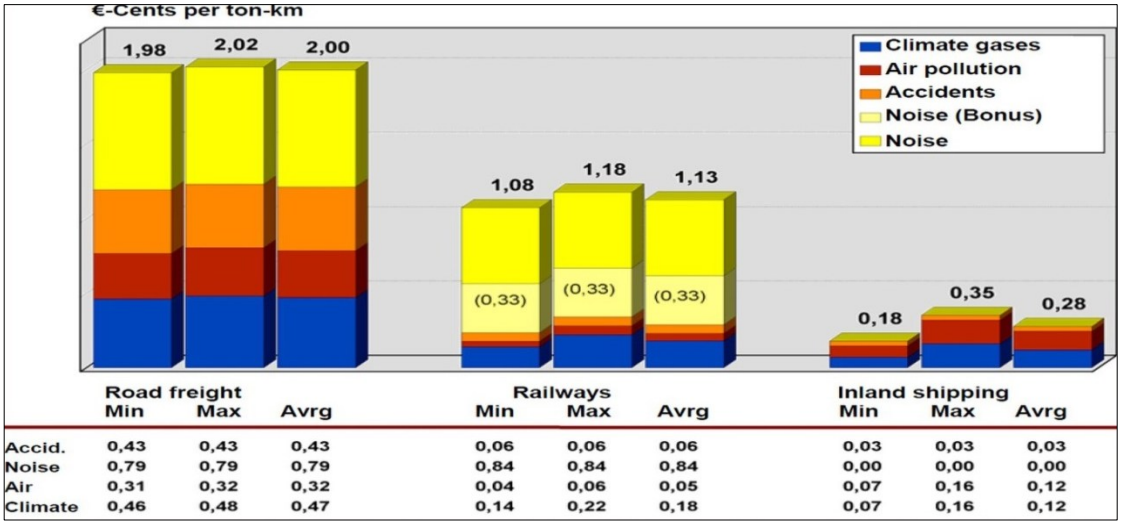


Figure 3-36 Summary of External Costs of Truck and Rail Freight in the US (1994, cents per ton-mile)
Source: By the author according to truck costs from Forkenbrock (1999)



	Road freight			Railways			Inland shipping		
	Min	Max	Avrg	Min	Max	Avrg	Min	Max	Avrg
Accid.	0,43	0,43	0,43	0,06	0,06	0,06	0,03	0,03	0,03
Noise	0,79	0,79	0,79	0,84	0,84	0,84	0,00	0,00	0,00
Air	0,31	0,32	0,32	0,04	0,06	0,05	0,07	0,16	0,12
Climate	0,46	0,48	0,47	0,14	0,22	0,18	0,07	0,16	0,12

Figure 3-37 Spread and Average Values of All External Costs (Noise, Accidents, Climate Gases, Air Pollution) for Container Freight on Selected Routes in Germany
Source: Economical and Ecological Comparison of Transport Modes: Road, Railways, Inland Waterways, Federal German Water and Shipping Administration, November 2007

■ Barrier of Urban Spatial Contexts

For urban and land use planning, railway and highway, as the most important traffic models, also impact the urban spatial structure in different ways. Compared with the railway, the highway is more difficult to intersect with urban road networks. Therefore, highways seem to be like the barriers that block pedestrians and non-motorized vehicles. Although there are interchanging points that provide the possibility for urban road networks to cross through highways, it still has an obvious barrier effect of blocking the urban spatial connections.

Therefore, highways are commonly planned at the city edge and as a belt that outlines the city border. One must also be very cautious when a social service facility or residential block needs to be planned near highways.

Unlike highways, in communities near airports, because the population density is commonly lower than in the city, and because railways occupy narrower land stripes than highways, there are many options for intersecting the railway with communities' road networks, which makes the railway easier to pass. According to the current status of localities' land use plans, many railway stations are located in town or community centers, and railway stations are often hot spots for attracting investments in retail and hospitality industries. Sometimes, neighboring railway networks, especially near passenger-train networks, is a great advantage for certain industries such as hospitality, retail and entertainment, and the land value is even higher than in other urban spaces in the vicinity.

Severance occurs where communities are split by traffic ('dynamic severance') or transport infrastructure ('static severance'). Dynamic severance happens when it is difficult to cross a road because there is too much traffic or it is moving fast. This leads to pedestrian delays, diversion to other crossing points, and accident risks. Static severance is caused by a new road or rail line splitting a community, leading to detour and lengthier journeys. Severance can significantly affect the social life of communities, with particular impacts on pedestrians and cyclists[77].

■ Conclusion

A common feature in the formation of new urbanism clusters is that all clusters impacted by airports are formed at the traffic joint points, or along traffic corridors. This means that accessibility plays a vital role in forming urban clusters under airport impact. However, different ground traffic models impact the urban spatial structure in different ways. For planners and authorities, advantages and disadvantages of ground traffic impacts need to be investigated as important reference for spatial planning in airport regions. The comparison of rail and highway impact on urbanism under influence of airports is as shown in the following table (3-7):

[77] "Airport Planning Guide." Aviation Environment Federation UK, 2006. accessed on July 2013, http://www.aef.org.uk/uploads/PlanningGuide2.pdf.

Railway	Positive	On-time performance
		Lower Cost for Passenger Trips
		Less Barrier Effect on Urban Development
		Less Air Pollution and Greenhouse Gases
		Less External Costs (Costs for air pollution, traffic accidents, congestion, etc.)
	Negative	Less Flexibility of Arrival/Departure Place
		Less Flexibility of Trip Time
		Higher Operating Costs for Small Shipments (Air-cargo)
Highway	Positive	More Flexibility of Arrival/Departure Place
		Flexibility of Trip Time
		Lower Operating Costs for Small Shipments
	Negative	Unreliable On-time Performance
		Higher Cost for Passenger Trips
		More Barrier Effect on Urban Development
		More Air Pollution and Greenhouse Gases
		Higher External Costs (Costs for air pollution, traffic accidents, congestion, etc.)

Table 3-7 Comparison of Disadvantage and Advantage of Railway and Highway Traffic Model
Source: By the author

3.5.3 Noise Impact on Surrounding Land Use Distribution

■ **Traffic Noise Impact on Health**

Noise pollution consistently ranks high on the list of citizens' concerns. It is estimated that over half of Europe's population is exposed to unacceptable noise levels. In the year 2000, about 44% of the population of the EU 25 countries (over 210 million people) were exposed to road traffic noise levels above 55 dB(A), the WHO guideline value for outdoor noise levels and the threshold for 'serious annoyance'[78]. More than 54 million people were exposed to road traffic noise levels over 65 dB(A), which is ten times louder than the

[78] L. C. Den Boer and Arno Schroten, "Traffic Noise Reduction in Europe," *Health Effects, Social Costs and Technical and Policy Options to Reduce Road and Rail Traffic Noise. CE Delft*, 2007, 12,

WHO guideline value. 35 million people in the EU25 (about 7%) were exposed to rail traffic noise above 55 dB in 2000, with 7 million of them exposed to noise over 65 dB from this source[79].

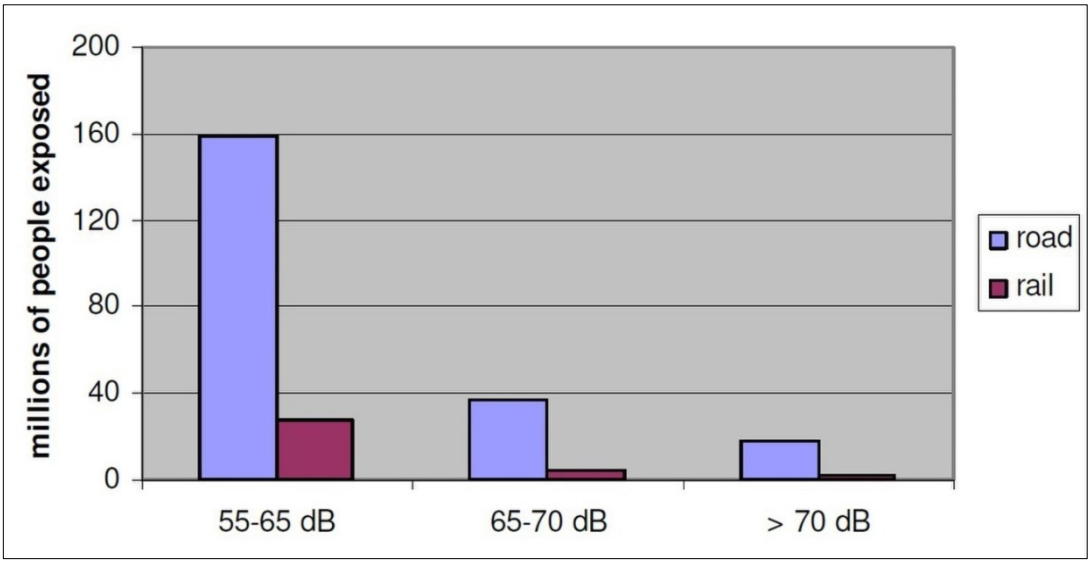


Figure 3-38 Number of People Exposed to Road and Rail Traffic Noise in 25 EU Countries in 2000
Source: INFRAS/IWW (2004), OECD/INFRAS/Herry (2002), calculations by CE Delft (for Estonia, Latvia, Lithuania)

In most European countries, the number of people exposed to noise levels below 55 dB is not reported, although noise below 55 dB may still trigger adverse effects like annoyance, sleep disturbance and reduced cognitive ability. The actual number of people exposed to levels of traffic noise that are potentially dangerous to their health will thus be higher than the figures presented in Figure 3-38. The data in this figure are for the year 2000. Given traffic growth and the fact that legislation and standards have hardly changed in the meantime, these exposure figures probably underestimate the true extent of the problem.[80]

Road transport is the major source of noise, followed by aircraft and railway. Traffic noise frequently exceeds the guideline values published by the WHO, and those exposed to traffic noise consequently suffer an array of adverse health effects. These include socio-psychological responses like annoyance and sleep disturbance, and physiological effects such as cardiovascular diseases (heart and circulatory problems) and impacts on mental health. In addition, traffic noise may also affect children's learning progress. Finally, prolonged, cumulative exposure to noise levels above 70 dB (A), common along major roads,

[79] Den Boer, L. C., and Arno Schroten. "Traffic Noise Reduction in Europe." Health Effects, Social Costs and Technical and Policy Options to Reduce Road and Rail Traffic Noise. CE Delft, 2007. 14

[80] Den Boer, L. C., and Arno Schroten. "Traffic Noise Reduction in Europe." Health Effects, Social Costs and Technical and Policy Options to Reduce Road and Rail Traffic Noise. CE Delft, 2007. 14

may lead to irreversible loss of hearing capacity[81].

Figure 3-39 summarizes the potential mechanisms of noise-induced health effects and their interactions. In the first place, noise exposure can lead to disturbance of sleep and daily activities, to annoyance and to stress. This stress can in turn trigger the production of certain hormones (e.g. cortisol, noradrenaline and adrenaline), which may lead to a variety of intermediate effects, including increased blood pressure. Over a prolonged period of exposure, these effects may in turn increase the risk of cardiovascular disease and psychiatric disorders. The degree to which noise leads to disturbance, annoyance and stress depends partly on individual characteristics, in particular a person's attitude and sensitivity to noise. Finally, the relation between noise and personal health and well-being is also influenced by external factors like physical and social environment and lifestyle[82].

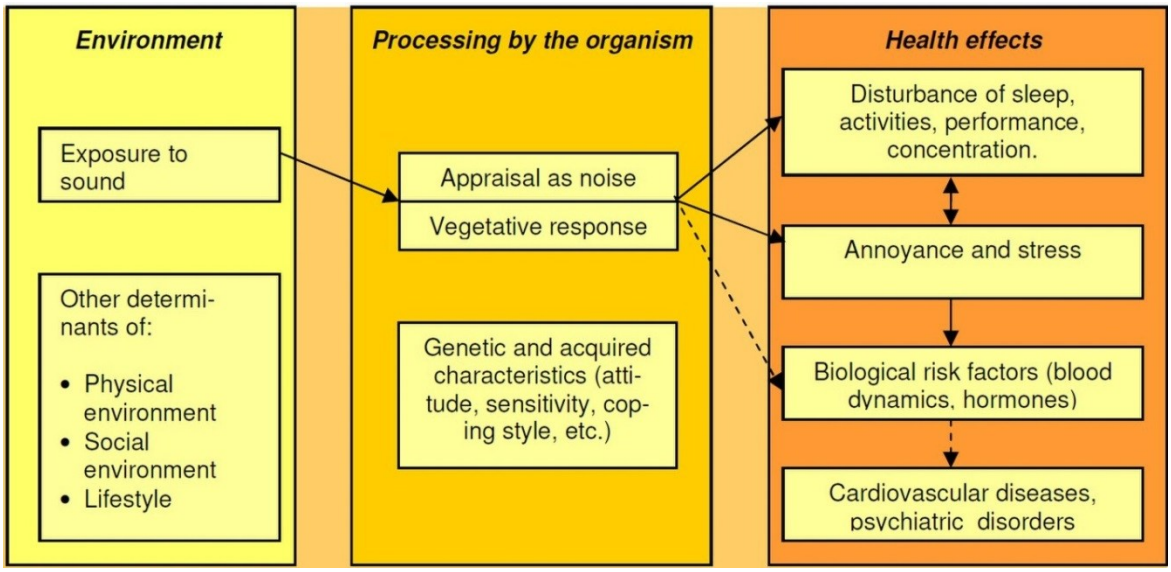


Figure 3-39 Mechanisms of Noise-Induced Health Effects
Source: HCN (Health Council of the Netherlands, 1999)

Some speculate that noise is not a major health problem because people adapt to it; however, according to one published source, this is a myth[83]. Noise stress has a measurable impact on human health. A 1993 study of Los Angeles International Airport (LAX) indicated that cardiovascular disease increased 18%, and accidental deaths increased 60% for people over 75. Suicides doubled for people between 45 and 54. Approximately 60

[81] Den Boer, L. C., and Arno Schroten. "Traffic Noise Reduction in Europe." Health Effects, Social Costs and Technical and Policy Options to Reduce Road and Rail Traffic Noise. CE Delft, 2007. 15

[82] Den Boer, L. C., and Arno Schroten. "Traffic Noise Reduction in Europe." Health Effects, Social Costs and Technical and Policy Options to Reduce Road and Rail Traffic Noise. CE Delft, 2007. 16

[83] Randall Bell, "The Impact of Airport Noise on Residential Real Estate," *The Appraisal Journal*, July 2001,311-321.

more people died each year[84]. A British study of doctors working at Springfield Mental Hospital shows that admissions per 1,000 people who live near London's Heathrow Airport are significantly higher than those from a population in a quieter area nearby. The Orange County Health Department in California published one of the most comprehensive health-related studies ever reviewed[85]. It utilizes the CNR Zones 1, 2 and 3 to reflect various impacts on health. It states that airport noise can specifically cause sleep disturbance, physiological stress reactions, temporary threshold shifts in hearing, interference with speech and communication, and psychological distress. Further, the study cites that health is not simply the absence of organic disease, but rather a total state of physical, mental and emotional well-being. The study states that "it is clear that excessive and needless noise constitutes a nuisance at best, a health hazard at worst"[86].

Typically, an emotional reaction occurs when a home-owner, for example, purchases a residence near an airport or freeway without really being aware of the noise, perhaps because the decision to buy is made on a weekend when the noise level is at its lowest. However, after an investment is made, and the full extent of the noise is realized, a feeling of regret and depression occurs. One couple interviewed during a community noise survey of Seal Beach bought a home adjacent to the San Diego freeway where sound levels averaged 60 dB(A) at night and 73 dB(A) during the day. Then, after living there a few days, they put the property up for sale. That was over four years ago and they still cannot sell the house. Their five-year-old daughter is reportedly developing hearing problems and has difficulty understanding the difference between similar words like candy, sandy or dandy. This couple realized their mistake, but can do nothing to rectify it. There is little doubt that they have been seriously affected, psychologically, by this situation.[87]

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[84] W. C. Meecham and N. A. Shaw, "Increase in Mortality Rates due to Aircraft Noise," *Schriftenreihe Des Vereins Für Wasser-, Boden- Und Lufthygiene* 88 (1993): 41–48.

[85] Robert S. Stone, Kenneth R. Regier, and Ellwyn Brickson, "The Human Effects of Exposures to Aircraft Noise in a Residential Environment," Division of Environmental Health, Orange County Health Department (May 19, 1972): 37

[86] Robert S. Stone, Kenneth R. Regier, and Ellwyn Brickson, "The Human Effects of Exposures to Aircraft Noise in a Residential Environment," Division of Environmental Health, Orange County Health Department (May 19, 1972): 37

[87] Randall Bell, "The Impact of Airport Noise on Residential Real Estate," *The Appraisal Journal*, July 2001, 311-321

■ General Guidelines of Land Use Distribution According to Airport Noise Impacts

Specific Environment	Critical Health Effect	Day:Laeq (DB(A))	Time Base (hours)
Day-Time and Evening Noise			
Outdoor living area	Serious annoyance, daytime and evening Moderate annoyance, daytime and evening	55-50	16 16
Dwellings, indoors	Speech intelligibility and moderate annoyance, daytime and evening	35	16
School classrooms and preschool, indoors	Speech intelligibility, disturbance of information extraction, message communication	35	During class
School playground, outdoors	Annoyance	55	During play
Hospital ward rooms, indoors	Sleep disturbance, daytime and evenings	30	16
Hospital, treatment rooms, indoors	Interference with rest and recovery	As low as possible	
Industrial, commercial, shopping and traffic areas, indoors and outdoors	Hearing Impairment	70	24
Festivals, entertainment events	Hearing impairments	100	4
Night Time Noise			
At the façade, outside	Body movements, awakening, self-reported sleep disturbance	30	During the night

Table 3-8 Selected Values From the WHO Community Noise Guidelines and WHO Night Noise Guidelines
Source: Guidelines for Community Noise, Birgitta Berglund, Thomas Lindvall, Dietrich H Schwela, World Health Organization, April 1999

The World Health Organization (WHO) recognizes community noise, including traffic noise, as a serious public health problem, prompting it to publish guidelines on community noise in 1999. These guidelines present noise levels above which a significant impact on human health and/or well-being is to be expected. In 2007 an extension of the guidelines was published (WHO, 2007), focusing on the health impacts of night-time noise. Table 3-8 presents the WHO guideline values arranged according to specific environments and critical health effects. The guideline values consider all identified adverse health effects for the specific environment. An adverse effect of noise refers to any temporary or long-term impairment of physical, psychological or social functioning that is associated with noise exposure. Specific noise limits have been set for each health effect, using the lowest noise level that produces an adverse health effect (i.e., the critical health effect). Although the guideline values refer to sound levels impacting the most exposed receiver at the listed

environments, they are applicable to the general population. The time base for LAeq for "daytime" and "night-time" is 12–16 hours and 8 hours, respectively. No time base is given for evenings, but typically the guideline value should be 5–10 dB lower than in the daytime. Other time bases are recommended for schools, preschools and playgrounds, depending on activity.[88]

According to aircraft noise impact on human health, FAA (U.S. Federal Aviation Administration) has published a uniform methodology for the development and preparation of airport noise exposure maps. That methodology includes an exclusive system of measuring noise at airports for which there is a highly reliable relationship between projected noise exposure and surveyed reactions of people to noise, along with a separate single system for determining the exposure of individuals to noise. It also identifies land uses which, for this part, are considered to be compatible with various exposures of individuals to noise around airports. This land use guide is also the most universal reference book for airport-encircling land use planning, according to the aero-noise impact.

[88] Birgitta Berglund et al., *Guidelines for Community Noise* (Geneva: World Health Organization, Occupational and Environmental Health, 1999), http://apps.who.int//iris/handle/10665/66217.

Legend:

Y (Yes) - Land use and related structures compatible without restrictions

N (No) - Land use and related structures are not compatible and should be prohibited

NLR - Noise Level Reduction (outdoor to indoor) to be achieved through incorporation of noise attenuation into the design and construction of the structure

DNL - Average Day-Night Sound Level

25, 30, 35 - Land use and related structures generally compatible; measures to achieve NLR of 25, 30, 35 dB must be incorporated into design and construction of structure.

Land Use	Below 65	65-70	70-75	75-80	80-85	Over 85
Residential, other than mobile homes and transient lodging	Y	N[1]	N[1]	N	N	N
Public						
School	Y	N[1]	N[1]	N	N	N
Hospital and Nursing Homes	Y	25	30	N	N	N
Government services	Y	Y	25	30	N	N
Churches, Auditoriums, Concert Halls	Y	25	30	N	N	N
Commercial						
Office, Business and Professional	Y	Y	25	30	N	N
Wholesale and Retail-Building Material, Hardware	Y	Y	Y[2]	Y[3]	Y[4]	Y
Retail Trade - General	Y	Y	25	30	N	N
Utilities	Y	Y	Y[2]	Y[3]	Y[4]	N
Communication	Y	Y	25	30	N	N
Manufacturing & Production						
Manufacture - General	Y	Y[2]	Y[3]	Y[4]	Y	N
Agricultural and Forestry	Y	Y	Y	Y	Y	Y
Livestock Farming and Breeding	Y	Y	Y	N	N	N
Recreational						
Outdoor Sports and Spectator Sports	Y	Y[5]	Y[5]	N	N	N
Amusement Parks, Resorts and Camps	Y	Y	Y	N	N	N
Outdoor Music Shells, Amphitheaters	Y	N	N	N	N	N
Riding Stables and Water Recreation	Y	Y	25	30	N	N

Notes:

1. When the community determines that residential or school uses must be allowed, measures to achieve an outdoor to indoor NLR of at least 25 dB and 30 dB should be incorporated into building codes and be considered in individual approvals. Normal residential construction can be expected to provide a NLR of 20 dB, thus, the reduction requirements are often stated as 5,10 or 15 dB over standard construction, and normally assume mechanical ventilation and closed windows year round. The use of NLR criteria will not, however, eliminate outdoor noise problems.
2. Measures to achieve NLR of 25 dB must be incorporated into the design and construction of portions of these buildings where the public is received, office areas, noise-sensitive areas, or where the normal noise level is low.
3. Measures to achieve NLR of 30 dB must be incorporated into the design and construction of portions of these buildings where the public is received, office areas, noise-sensitive areas, or where the normal noise level is low.
4. Measures to achieve NLR of 35 dB must be incorporated into the design and construction of portions of these buildings where the public is received, office areas, noise-sensitive areas, or where the normal noise level is low.
5. Land use is compatible provided special sound reinforcement systems are installed.

Table 3-9 Noise Compatibility

Source: FAA Polices, Guidance and Regulations - Appendix A, Federal Aviation Administration, 24 Sept 2004

■ Airport Noise Impact on Land Value

In research of real estate damage issues, the topic of airport noise and its impact on property market values are particularly well-documented fields. There are dozens of published studies on the topic, all of which virtually come to the conclusion that homes under or near the flight corridors of national or international airports experience some diminution in property market values[89].

For most people, noise is a significant issue, and there is a segment of the population that will live under an outstanding flight corridor if enticed through a discount on the price. However, a slight majority of the market will not purchase a property that is next to a major airport at any discount[90]. Similarly, a significant portion of the market will neither purchase a property that is close to a motorway, nor one that is a few miles from a major airport. One of the most important studies published to date was conducted for the Federal Aviation Administration in 1994[91]. It studied three airports using a regression analysis: Baltimore International Airport (BWI), Los Angeles International Airport (LAX), and John F. Kennedy Airport (JFK) in New York. The results indicated a consistently negative impact on residential property market values.

The BWI study had significant limitations, yet reflected homes near airports that would have a market value loss ranging from -$627 to -$14,595 per home. The LAX study was more straightforward. It included an analysis of both low-priced and moderately priced neighborhoods. The study indicated that the adjusted market value of a low-priced home was $1,268 less if impacted by airport noise, or -0.07 per dB(A) above a quiet threshold. Moderately priced homes incurred a $60,873 loss if impacted, or 1.12% per dB(A) above a quiet threshold (which is not specified). Losses of the total home market value ranged from -0.8% for low-priced homes up to -15.7% to -19% for moderately priced ones[92].

The JFK study includes low-, moderately and high-priced homes. It indicates a loss of -0.12% per dB(A) for low-priced residences, -0.46% per dB(A) for moderately priced ones, and -1.35% per dB(A) for high-priced ones.

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[89] Bell, "The Impact of Airport Noise on Residential Real Estate."

[90] Desai Vijay and Jack Chen, The Effect of Airport Noise on Housing Value: A Summary Report (Booz. Allen & Hamilton Inc., September 1994), 17.

[91] Desai Vijay and Jack Chen, The Effect of Airport Noise on Housing Value: A Summary Report (Booz. Allen & Hamilton Inc., September 1994), 17.

[92] Desai Vijay and Jack Chen, The Effect of Airport Noise on Housing Value: A Summary Report (Booz. Allen & Hamilton Inc., September 1994), 17.

Class of Property	Noise Zones		
	35-45 NNI	45-55NNI	55+NNI
Low	0.0	2.9	5.0
Medium	2.6	6.3	10.5
High	3.3	13.3	22.5

Table 3-10 Percentage of Price Depreciation of House Value
Source: Jonathan H. Mark, A Preference Approach to Measuring the Impact of Environmental Externalities

The FAA study, while lacking a complete discussion of many issues, yields some significant information. First, entry-level homes are impacted less compared to moderately priced ones. In fact, the loss in market value for low-priced homes is generally minimal. This trend could be expected, as high-priced residences are often in areas with more desirable neighborhood traits. Second, the study shows that the loss for moderately priced homes is as high as 19%, a significant figure as conventional loans often require a down payment of 20%. In other words, home buyers who purchase a home without knowledge of plans for an airport to be built nearby may stand to lose most or all of their equity if an airport is subsequently developed. Further, the reduction in value of a high-priced home will be approximately 2.5 times that of a moderately priced one. This finding is also illustrated by a British study[93].

While utilizing a different noise measurement method of NNI, these studies reflect much of the same concept as other ones. Namely, the higher the relative price of a property, the higher the diminution in value. According to the studies above, the highest loss is of 22.5% to 29% for high-class housing, which reconciles somewhat with the 19% loss reflected in the FAA study for moderately priced housing. These results are also slightly consistent with yet another published study that cites losses of 0.4% to 1.1% per NNI[94].[95].

In view of the previous studies, on the airport noise impact on the value of residential properties it could be concluded as follows:

Airport noise has a universal negative impact on residential property values, especially direct under or near flight routes surrounding the airport.

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[93] Randall Bell, "The Impact of Airport Noise on Residential Real Estate," *The Appraisal Journal*, July 2001, 311-321

[94] Eran J. Feitelson, Robert E. Hurd and Richard R. Mudge, "The Impact of Airport Noise on Willingness to Pay for Residences", Pergamon (April 5, 1996)

[95] Randall Bell, "The Impact of Airport Noise on Residential Real Estate," *The Appraisal Journal*, July 2001, 311-321

- There is a correlation between noise levels, as measured by noise contours, and the suffered diminution in value. The nearer the airport noise contour, the greater the loss of residential property value will be.
- There is a correlation between the class of residential property and the value that the property will lose. The higher the class of the residential property, the more the impact of airport noise on property value will be.
- Rural areas tend to be impacted more than urban areas.
- The number of flights is less important than the loudness and variability of the loudness of single events[96].

[96] Terrence Levesque, "Modelling the Effects of Airport Noise on Residential Housing Markets," *Journal of Transport Economics and Policy* 2, no. 28 (May 1994): 199–200.

3.6 **Hot Spot Analysis of Land Use Distribution Features**

3.6.1 Approach of Hot Spot Analysis

■ The Methodology of Hot Spot Analysis

The Getis-Ord local statistic is given as:

$$G_i^* = \frac{\sum_{j=1}^{n} w_{i,j}x_j - \bar{X}\sum_{j=1}^{n} w_{i,j}}{S\sqrt{\frac{\left[n\sum_{j=1}^{n} w_{i,j}^2 - \left(\sum_{j=1}^{n} w_{i,j}\right)^2\right]}{n-1}}} \quad (1)$$

where x_j is the attribute value for feature j, $w_{i,j}$ is the spatial weight between feature i and j, n is equal to the total number of features and:

$$\bar{X} = \frac{\sum_{j=1}^{n} x_j}{n} \quad (2)$$

$$S = \sqrt{\frac{\sum_{j=1}^{n} x_j^2}{n} - \left(\bar{X}\right)^2} \quad (3)$$

The G_i^* statistic is a z-score so no further calculations are required.

Figure 3-40 Formula of Getis-Ord Gi* Analysis
Source: www.arcgis.com

The Hot Spot Analysis tool calculates the Getis-Ord Gi* statistic (pronounced G-i-star) for each feature in a dataset. The resultant z-scores and p-values tell where features with either high or low values cluster spatially. This tool works by looking at each feature within the context of neighboring features. Unlike density analysis, a feature with a high value is interesting, but may not be a statistically significant hot spot. To be one, a feature should have a high value and be surrounded by other features with high values as well. The local sum for a feature and its neighbors is compared proportionally to the sum of all features; when the local sum is very different from the expected local sum, and that difference is too large to be the result of random chance, then a statistically significant z-score result[97].

■ Z-Score and P-Value

The p-value is a probability. For the pattern analysis tools, it is the probability that the observed spatial pattern was created by some random process. When the p-value is very

[97] Hot Spot Analysis (Getis-Ord GI*), ArcGis Help 10.1, Esri. http://resources.arcgis.com

small, it means it is very unlikely (small probability) that the observed spatial pattern is the result of random processes, so one can reject the null hypothesis[98].

Z-scores are simply standard deviations. If, for example, a tool returns a z-score of +2.5, one would say that the result is 2.5 standard deviations. Both z-scores and p-values are associated with the standard normal distribution, as shown below[99].

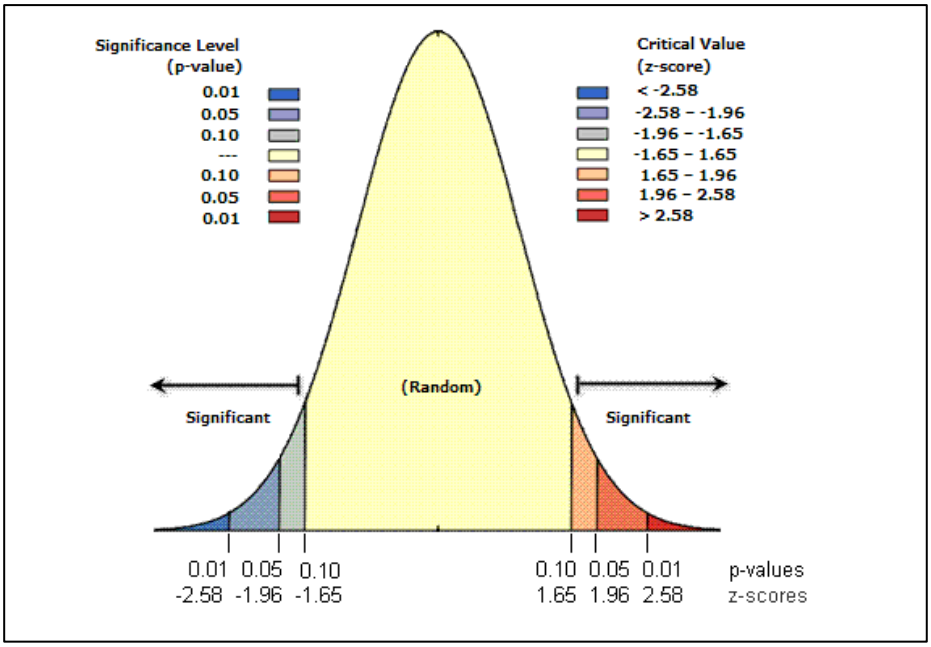

Figure 3-41Significance Level and Critical Value of P-Value and Z-Score
Source: www.arcgis.com

Very high or very low (negative) z-scores, associated with very small p-values, are found in the tails of the normal distribution. When running a feature pattern analysis tool and it yields small p-values and either a very high or a very low z-score, this indicates it is unlikely that the observed spatial pattern reflects the theoretical random pattern represented by the null hypothesis (CSR). The table below shows the critical p-values and z-scores for different confidence levels[100].

[98] What is G-Score? What is P-Value?, ArcGis Help 10.1, Esri. http://resources.arcgis.com

[99] What is G-Score? What is P-Value?, ArcGis Help 10.1, Esri. http://resources.arcgis.com

[100] What is G-Score? What is P-Value?, ArcGis Help 10.1, Esri. http://resources.arcgis.com

z-score (Standard Deviations)	p-value (Probability)	Confidence level
< -1.65 or > +1.65	< 0.10	90%
< -1.96 or > +1.96	< 0.05	95%
< -2.58 or > +2.58	< 0.01	99%

Table 3-11Critical p-Value and z-Scores for Different Confidence Levels
Source: www.arcgis.com

■ **Application of Hot Spot Analysis**

In this Chapter, the hot spot analysis (Getis-Ord Gi* statistic) is used to investigate hot spots and cold spots of each land use of airport-surrounding communities located around case study airports. The statistic objects are defined as the current status of each land use within a scope of 15-km radius in a circle around the airport.

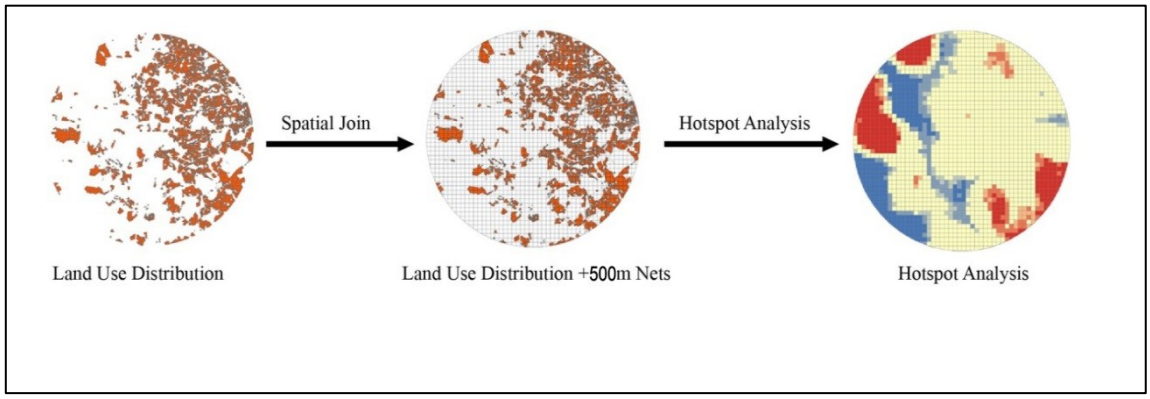

Figure 3-42Application of Land Use Hot Spot Analysis
Source: By the author

The first step is to clip the land use features in a 15-km radius circle, with the airport as its geometric center. The land use distribution status in circles is considered as the statistic field. The land use map includes the geographical information such as area, name and type of each piece of land use. Then, a fishnet of same size is created with 500m cell size, and the land use distribution map is joined within the fishnet. Since then, each cell in the fishnet has the geographical information of the land use map it joined. The last step is to use the hot spot analysis tool to assess the distribution of hot spots of each land use, thus to summarize common land use distribution features in the airport region.

3.6.2 Hot Spot Analysis of Airport Noise and Ground Traffic Impact on Land Use Distribution

For planners and local authorities, site selection of different land use is as important as the

proportion of each land use in the area. In other words, when facing a planning assignment, as precondition for the planning process it is important not only to consider the volume of different land uses, but also to plan different land uses in accurate sites. Therefore, in this section, hot spot analysis is introduced for investigating the ground traffic and airport noise contour impact on the location of each land use in airport-adjacent localities. In a further step, it aims to explore land use distribution features for guiding the planning and distribution of land use for communities near airports.

The scope of the analysis is defined as a 15-km radius surrounding the airport. The reasons for defining the scope are that:

1. It may contain nearly all of the 55 dB(A) noise contour area of all case study airports;
2. The distance of 15 km could better explain the relation between the airport and its connected main city;
3. A 15 km range could not only explain the ground traffic close to the airport, but also the traffic impact in certain distance to airports.

The noise maps are selected from publications or official reports of administrations or airport operators. The London Heathrow airport noise map is the "Heathrow 2011 Lden (71% W/ 29% E) contours", selected from "Strategic Noise Maps for Heathrow Airport 2011"[101]; the London Gatwick airport noise map is the "Gatwick 2011 Actual Modal Split (78% W/ 22% E) Leq Contours", selected from "Noise Exposure Contours for Gatwick Airport 2011"[102];

E) Leq Contours", selected from "Noise Exposure Contours for Gatwick Airport 2011"[103]; the Frankfurt airport noise map is the "Frankfurt Airport Noise Lden 2007" from the "Actual Noise Plan Hessen"[104]; the Munich Airport Noise Map is the "Noise Map of Munich Airport Lden" from "Noise Pollution Map Bavaria 2010"[105].

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[101] *J Lee, L Edmonds, and J Patel, Strategic Noise Maps for Heathrow Airport 2011* (London, UK: Civil Aviation Authority, June 2013).

[102] *J Lee, L Edmonds, and J Patel, Strategic Noise Maps for Heathrow Airport 2011* (London, UK: Civil Aviation Authority, June 2013).

[103] *J Lee, L Edmonds, and J Patel, Strategic Noise Maps for Heathrow Airport 2011* (London, UK: Civil Aviation Authority, June 2013).

[104] *Actual Noise Plan Hesse-Sub-Plan Frankfurt Airport* (in German), Presidium of Darmstadt, September 2012

[105] Noise Pollution Map Bavaria (2010), Department of Environment Bavaria, accessed 09,2013 http://www.bis.bayern.de/bis/initParams.do

■ Hot Spot/Cold Spot Analysis of Residential Land Use Within the 15-km Scope of an Airport

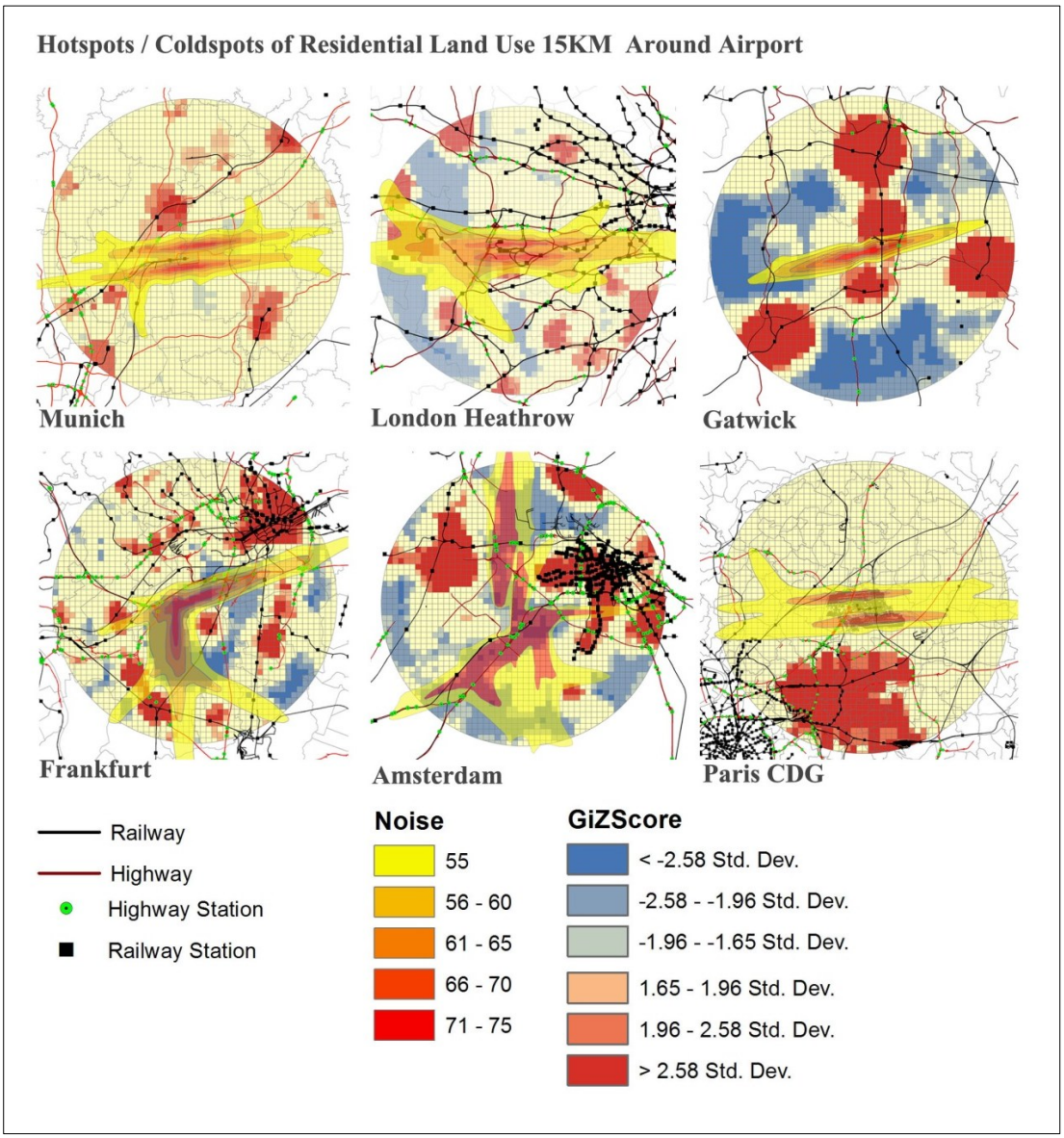

Figure 3-43 Hot Spot / Cold Spot Analysis of Airport Noise and Ground Traffic Impact on Residential Clustering
Source: By the author

Hot Spot / Cold Spot analysis of residential clusters was overlaid with ground traffic map (highway and railway) and airport noise contour in order to investigate the ground traffic and airport noise impact on residential land use development in airport-adjacent communities. Several significant residential clustering features could be summarized.

First, airports are considered not only as superior locations for commercial and industrial development, but also for housing. Although airports have a negative impact on residential clusters according to the previous study of airport impact range on residential land use, certain locations close to airports may also become hot spots for residential development. The precondition for this is that it must avoid the noise interference from the airport and outside the airport noise contour. For example, the residential area surrounding the Frankfurt and Amsterdam Schiphol airports reflect a punctual distribution surrounding the airport that fills the gap between airport noise impact regions. The feature could be explained by the noise contour as an open palm, with the residential land uses filling the gaps between each finger.

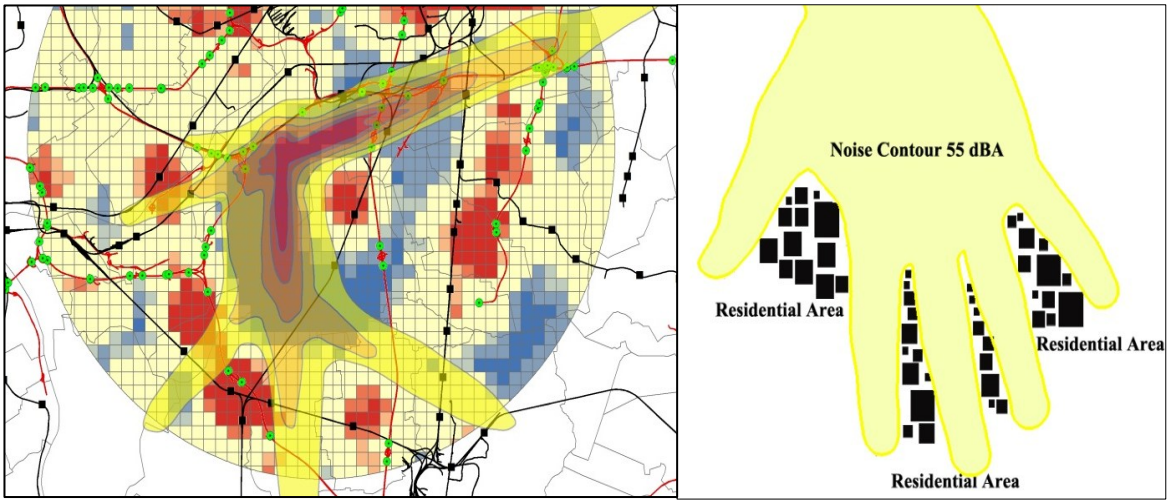

Figure 3-44 Airport Noise Contour Impact on Residential Land Use Distribution - Frankfurt Airport
Source: By the author

Second, when comparing localities situated in the equivalent scope of the airport, those pointing in the opposite direction of the airport noise contour will enjoy more advantages and have more opportunities for developing new residential areas than localities in the same direction of the airport noise contour. Therefore, for communities within the same direction of the airport noise contour, noise risks should be evaluated cautiously before new residential area developments are planned.

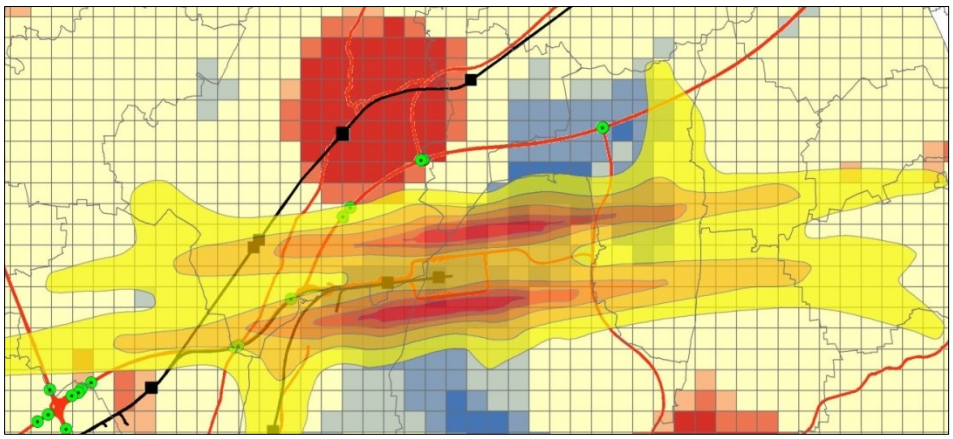

Figure 3-45 Residential Land Use Distribution and the Direction of Noise Contour Near Gatwick Airport
Source: By the author

Third, passenger rails have more positive influence than freight rail and highway for residential land use clusters. Unlike the role of passenger railways, highways play a negative role in residential land use clustering, especially at the joint points of highway and urban roads. The highway joint points serve as cold spots according to the hot spot / cold spot analysis. Therefore, for airport-neighboring communities planning a new residential area, the passenger railway station could be considered as a cluster. A 15-minute walking distance to a passenger railway station or in the range of 3-km distance to railway stations could be seen as the suitable region for residential development. The highway could be considered as a boundary of the residential area for airport-surrounding localities, and the residential land use should keep a certain distance to the highway and highway joints.

Although accessibility to airport and its connected city is an important determinant for residential land use clusters, because of the negative impacts of traffic noise, and also because the land value surrounding passenger railways as well as railway stations is higher, the land use is less suitable for residential than commercial or business and industrial purposes. Therefore, even though a railway station could be considered as a core of residential land use, the inner region of railway stations should be more appropriate for commercial and other service facilities.

■ **Hot Spot / Cold Spot Analysis of Commercial Land Use Within the 25-km Scope of an Airport**

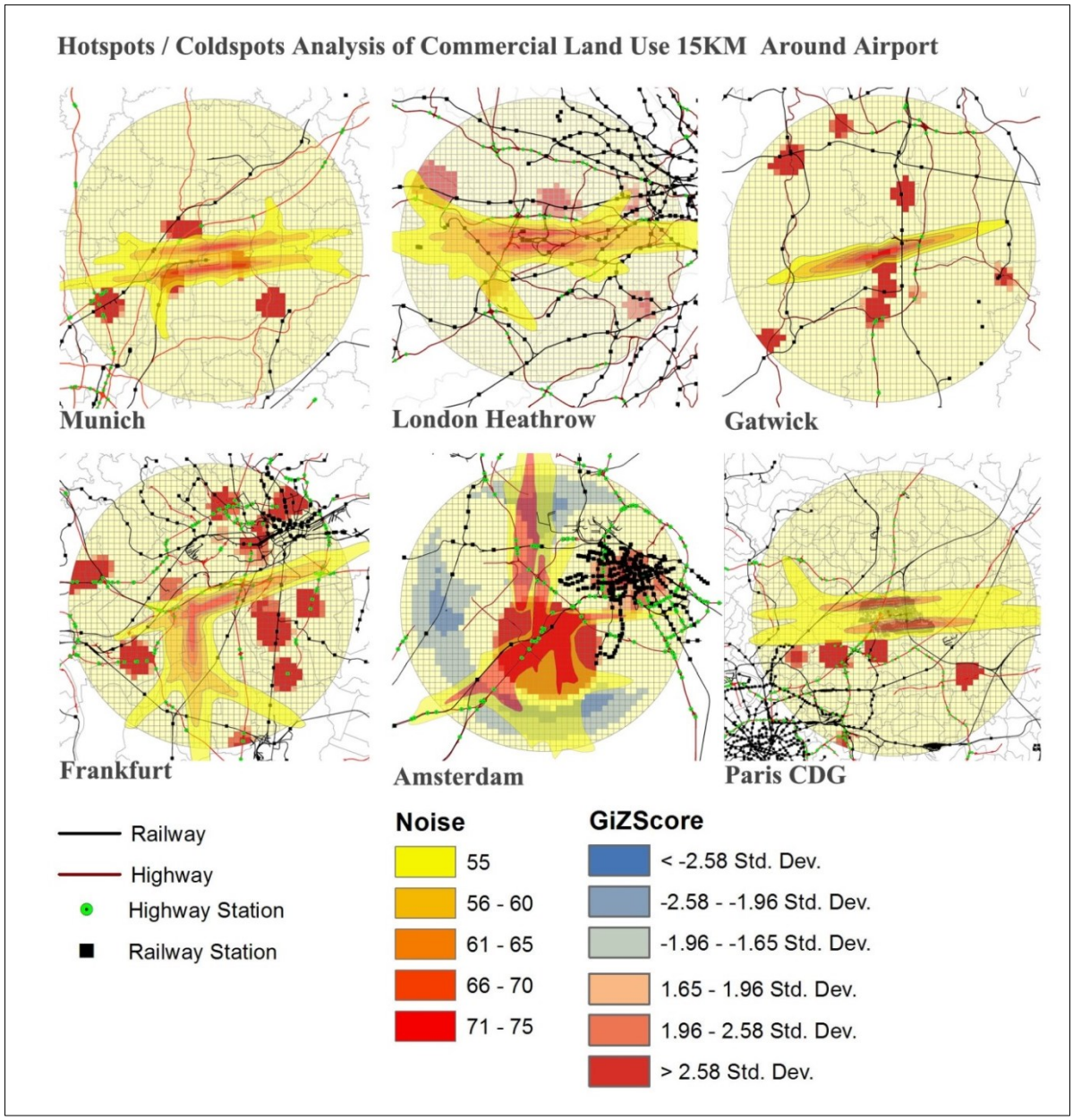

Figure 3-46 Hot Spot / Cold Spot analysis of Commercial Land Use around Case Study Airports Within the 15-km Scope
Source: By the author

Based on the hot spot / cold spot analysis of commercial land use distribution, several features could be summarized, as follows.

First, the airport itself is the most attractive factor for commercial clustering. The result of hot spot analysis of commercial distribution shows that the commercial clusters are formed in all seven case study airports or communities next to them. Therefore, the conclusion could be drawn that the airport attractiveness for commercial clusters is much greater than the airport noise impact, and commercial land use such as office buildings, retail,

wholesale, not to mention hospitality facilities, could be as well located at the nearest region around the airport. In the case study of the Amsterdam airport, the level of commercial clusters at Schiphol is even higher than in the city of Amsterdam itself. In other words, Schiphol airport has already become one of the commercial centers of Amsterdam city.

The result of hot spot analysis also shows that the commercial land use clusters were impacted by both the ground traffic linkages and the service population of communities they serves, but not depend on the airport. The passenger rail has a great impact on commercial land use clusters, whereas the urban region surrounding the passenger railway station enjoys superior opportunities for commercial development. However, the analysis shows that not all regions surrounding railway stations will develop into commercial hot spots. The commercial land use cluster is also impacted by the population that the railway station serves, or the population and its density in railway stations host communities. This is because, according to the hot spot analysis, only localities with a certain high population density have commercial clusters. Therefore, the precondition for railway stations in surrounding urban regions to be transformed into commercial hot spots is that the railway station service population must reach a certain number. In other words, the residential land use clustering also has impacts on commercial land use clusters.

Third, according to hot spot analysis of commercial land use distribution, highway and railway impact the commercial land use in different ways. Unlike ground traffic effects on residential land use distribution, commercial land use hot spots also appear around the highway joint points. This means that highways have a positive impact on commercial clusters as well. However, when the analysis goes deeper, one can find that railway and highway attractiveness to commercial clusters are of different types. Hot spots of surrounding passenger railway stations mainly include retail, office buildings and hospitality facilities such as hotels and restaurants. The commercial land use hot spots of surrounding highway joint points mainly include factory stores, wholesale and retail for building material, furniture, and hardware and farm equipment. This may be the case because this kind of larger-value merchandise needs large storage spaces is difficult to deliver by public transportation, and also because the visiting frequency of this kind of commercial facilities is lower than in common retail. Moreover, localities near airport, but not enjoying the best access conditions, or located at the opposite airport-city direction, are more suitable to develop such types of commercial facilities rather than common retail and hospitality functions.

■ **Hot Spot/Cold Spot Analysis of Industrial Land Use Within the 25-km Scope of an Airport**

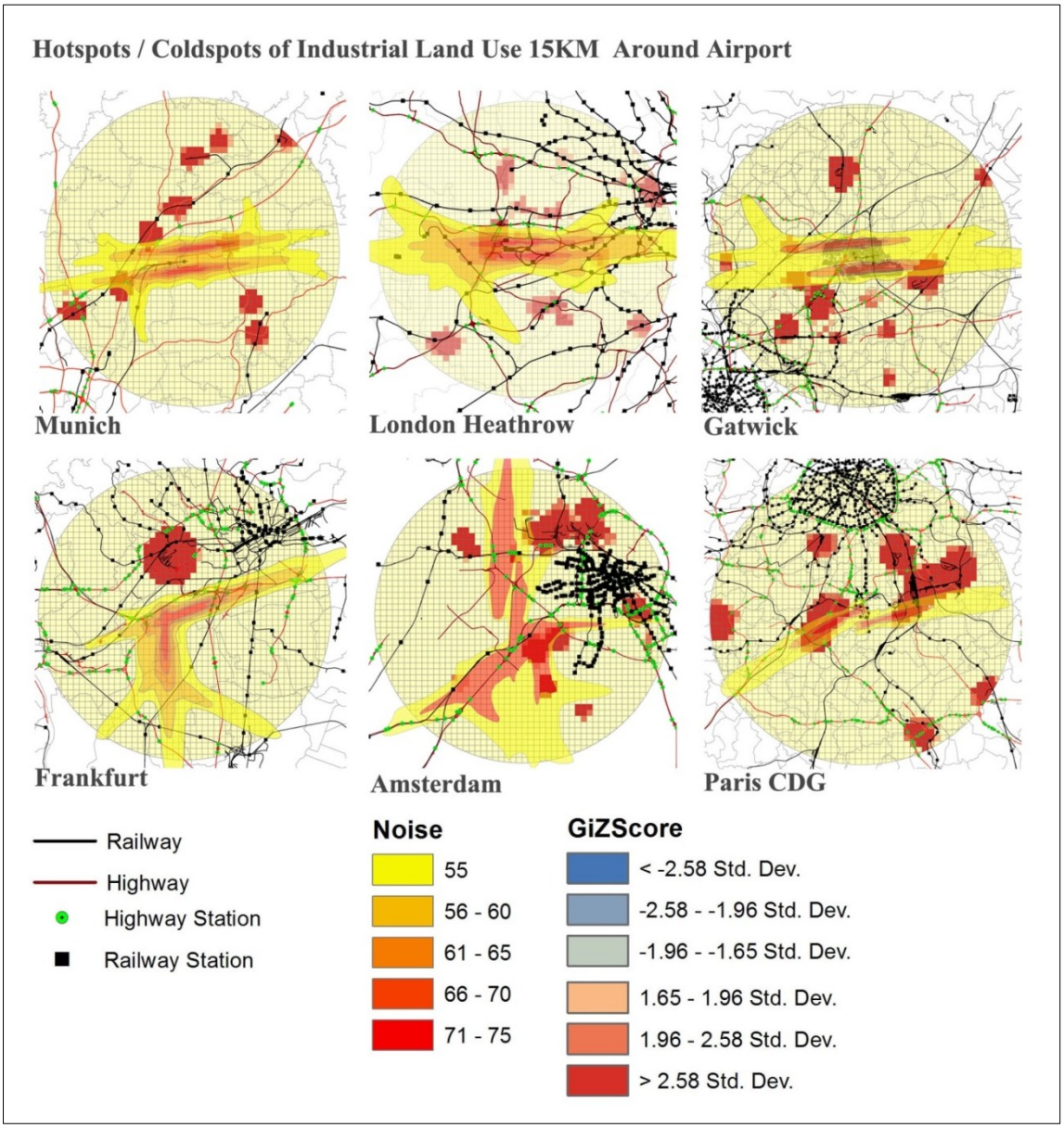

Figure 3-47 Hot Spot / Cold Spot analysis of Industrial Land Use Around Case Study Airports Within the 15-km Scope
Source: By the author

According to hot spot / cold spot analysis of industrial land use distribution (Figure 3-47), several features could be summarized, as follows.

First, compared to commercial land use that mainly clusters around the airport, the industrial land use distributions are more dispersed. According to statistics of the total area of commercial and industrial land use within a scope of around 15 km, the use is much larger than the commercial land use. Therefore, although airports have strong attractiveness for industrial land use distribution, it is not possible to establish such a large area of

industrial land use inside a small region around the airport. Communities located within a larger radius to the airport may also have opportunities to share a certain proportion of industrial development. An example for this could be shown by the hot spot analysis of industrial land use in the Munich airport. Here, the commercial hot spots are mainly located in the airport and communities' centers or railway stations that serve a large part of the population. However, the industrial land use is more dispersed, and scattered along the railway and highway corridors. Therefore, for industrial land use, due to needing a larger area for development, the localities surrounding the ground traffic corridors may share more opportunities of industrial than commercial development.

Second, the communities' population is not an influencing factor for industrial land use clusters. As revealed by the analysis of commercial land use distribution, the commercial hot spots should have a certain number of service people, and the location of commercial hot spots should be easy to access. However, according to hot spot analysis of industrial land use distribution, in judging or evaluating the clusters of industrial land use, service population is not an influencing factor anymore.

Third, in explaining ground traffic impact on industrial land use distribution, there are three influencing factors that may induce the formation of industrial land use hot spots. They are:

1. The airport itself

Commonly, a large international airport has a superior ground traffic connectivity serving airport passengers and air cargo transport from/to the airport and its periphery. An airport itself serves as a hub not only for air transportation, but also regionally for ground transportation. In addition, there is at least one logistic center located around the airport that serves air-cargo transits from/to airports. Therefore, such privileged transportation for industrial progress gains great attraction for industrial land use development. According to hot spot analysis of industrial land use distribution in the seven case study airports, all cases had at least one industrial land use hot spot next to them, where were situated the most air-related manufactures, being named airport industrial parks.

Taking London Gatwick airport as an example, next to it was formed the Manor Royal Business District, which is the largest business & logistics and manufacturing park in the UK, covering an area of 240 hectares, and constituting a premier mixed activity employment hub. Over 500 businesses and 30,000 people work in Manor Royal, attracted by its proximity to London Gatwick Airport and the M23 motorway. The size of businesses already located here range from billion-pound international businesses such as Thales (French), Doosan (Korean), Elekta (Swedish) and Varian (US) to small enterprises.

2. The place has good connections with both passenger rail and highway joints

According to hot spot analysis of industrial land use distribution surrounding case study airports, a feature was shown in all case study airports that industrial hot spots must have a good connectivity to both railway and highway network.

As many literature sources have discussed, the road freight transport has advantages such as being more flexible with regards to arrival/departure place, more adjustable as to departure and arriving time, and that the operation costs are also lower than railway in the case of small-value goods transportation. Considering that airport-related manufacturing and logistics are commonly in smaller value and based on on-time service competition, highway freight transportation for industrial districts is more important than railway freight transportation. Although all selected case study airports are among the top-20 European airports with large amount air cargo, not all have a direct connection to the rail freight network. In other words, highway freight transportation is more significant than railway freight transportation in serving airport-related industries.

Although railway network plays a minor role in freight transportation for airport-related industrial districts, a convenient passenger railway network is also significant for industrial development. An industrial district having direct passenger rail connection will be more convenient for employees to travel from/to workplace, and more accessible for meeting customers in on site.

The hot spot analysis of industrial distribution also proves the importance of highway and passenger railway network in selecting the position of new industrial districts. All industrial land use hot spots are clustered at the cross of highways and railways, or in-between the gap of railway and highway parallels. In other words, communities located at the crossing of highway and railway networks will have better opportunities of attracting new industrial development.

3.6.3 Hot Spot Analysis of Interaction between Different Land Uses

Different types of land use could not be considered separately in urban planning. Development of one type of land use may as well impact other types, and all types are correlated with each other. For example, when planning a certain area of residential land use, commercial facilities such as restaurants, retail trade and supermarkets will also be considered as a whole. Controversially, when planning an area of commercial facilities, the attractiveness for residential development in its service radius should also be considered.

Further, each type of land use will have different degrees of impact on other types.

The aim of this study was to investigate the correlation between different types of land use, and to investigate the degree of influence of urban land use impacts on other uses. The study is based on hot spot analysis of each land use in a 15-km scope surrounding case study airports.

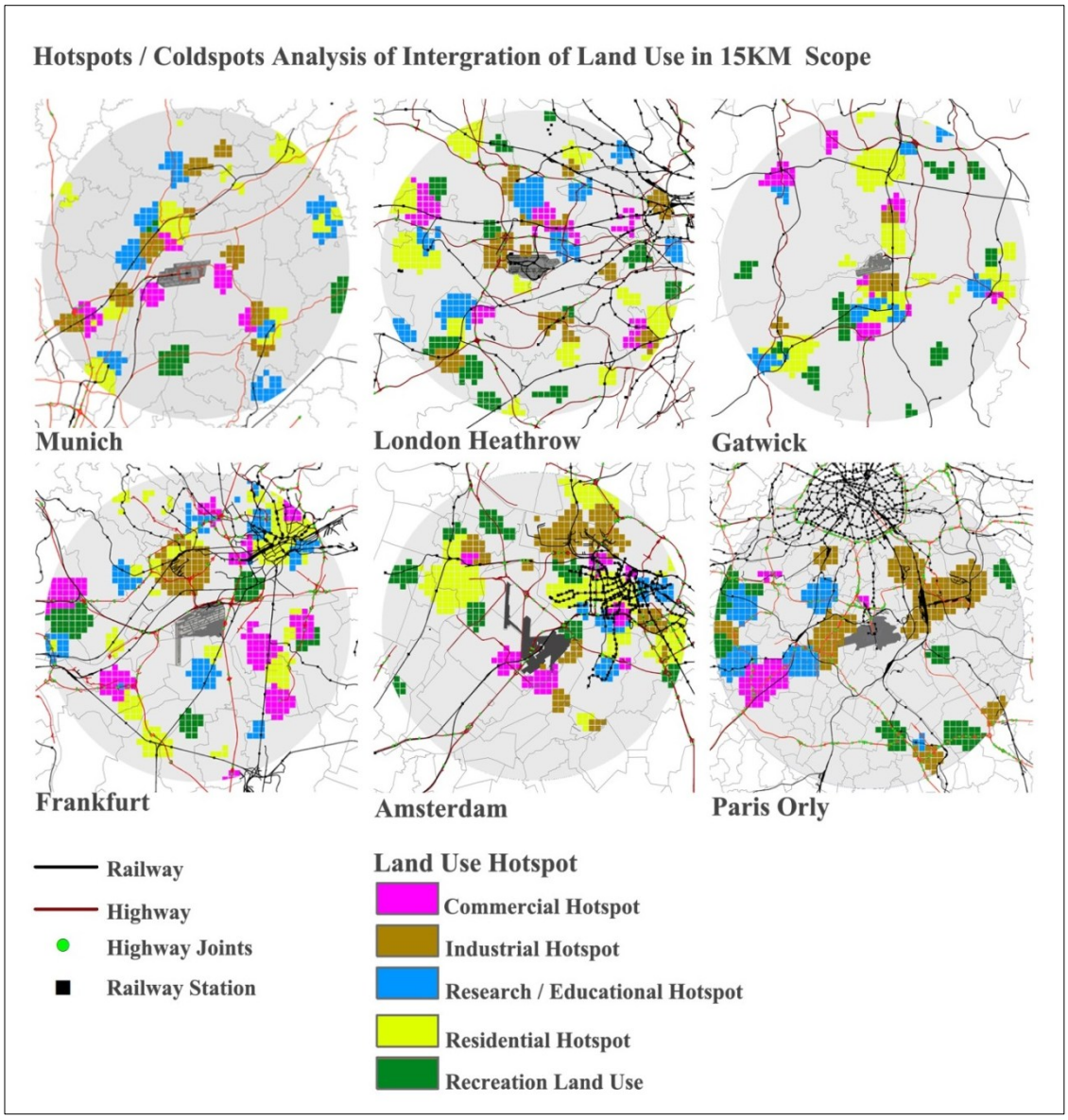

Figure 3-48 Hot Spot Analysis of Land Use Integration Within the 15-km Scope
Source: By the author

The above figure is an integrate map of clusters of five types of urban land use in six case study airports. The selected land use includes industrial, commercial, higher educational and research facilities, as well as residential and sport and leisure facilities. The industrial land use includes manufactures, workshops, warehouses, logistic centers, etc.; the commercial land use includes retail trade, supermarkets, office buildings, residential area,

hotels and other hospitality facilities; the educational land use includes universities, colleges, libraries and laboratories, institutions and other research and higher-education facilities; the residential use includes all types of dwelling facilities; and the sport and leisure land use includes stadiums, sports centers, recreation grounds, pitches, gardens, and golf courts.

According to the hot spot analysis, the correlation between each land use could be explained as in the following chart (3-49):

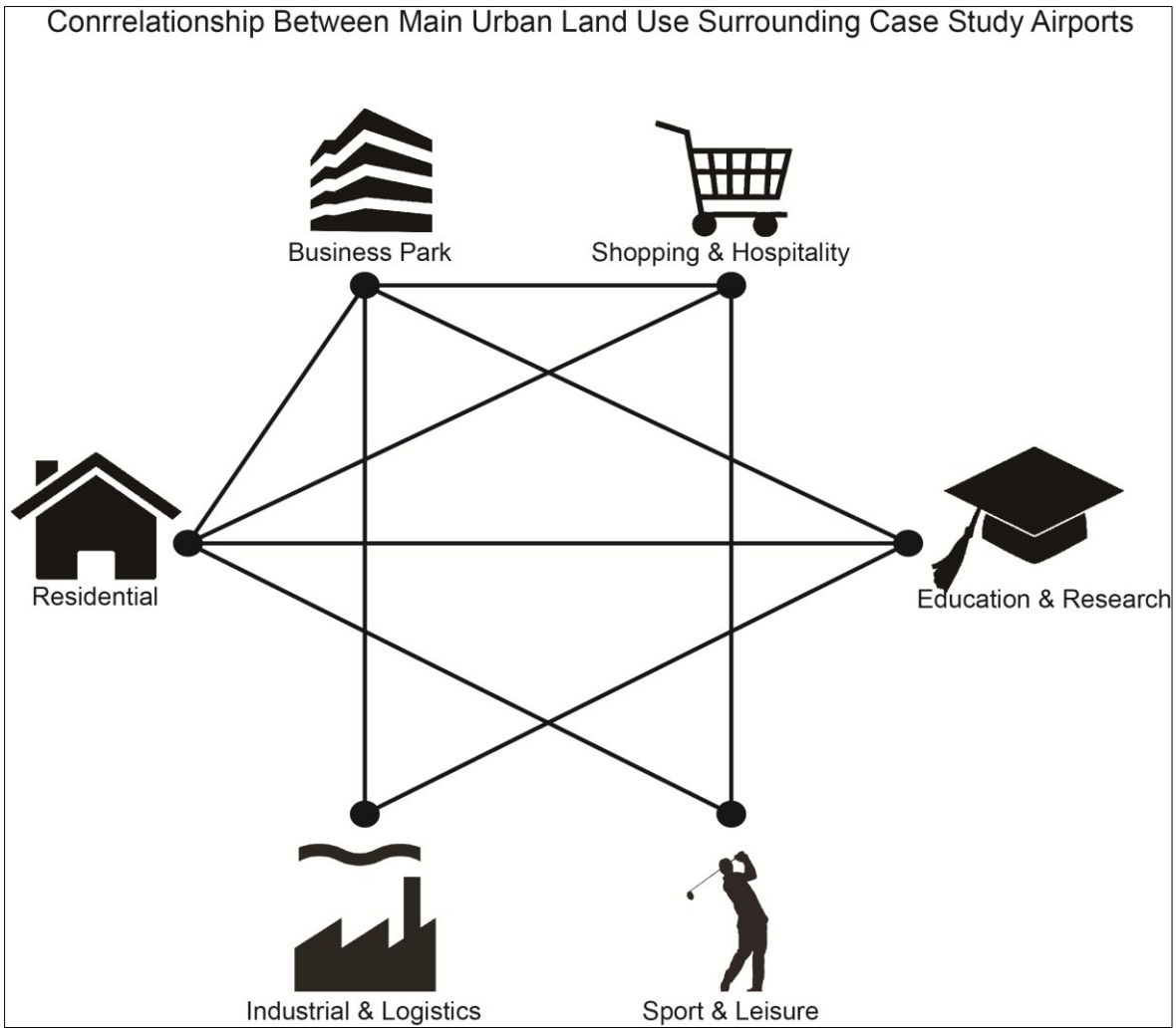

Figure 3-49 Correlation between Main Urban Land Uses Around Case Study Airports
Source: By the author

The integrated land use map indicates that, except for industrial land use, all other main urban land use hot spots are close to residential cluster hot spots. A formation of residential hot spots may need supporting facilities such as kindergartens, primary schools and high schools in serving local teenagers; shopping facilities and sports areas are also needs in serving the consumption and recreation of local residents. Moreover, residential facilities also provide housing for employees working in airport regions, office buildings,

universities and sports facilities. Therefore, residential use is the most influential factor in enhancing other urban developments.

Industrial and logistics land uses are commonly integrated with office buildings at the closest site of the airport. Taking the business parks surrounding London Gatwick as an example, the area of business and industrial complex include business and manufacturing such as advanced manufacturing and engineering; aviation, aerospace and defense; environmental technologies; foods and drinks; financial and professional services; and life sciences, health technologies and medical devices. In this sense, there is no clear boundary between industrial and business land uses. The integrated area surrounding the airport is formed by industries and business facilities in most complexes.

According to integrated hot spot analysis map, industrial and business land uses are also commonly close to universities and research institutes. Many research facilities are directly located in business parks of case study airports. In some cases, research institutes and universities may become the leading power of development of the business parks surrounding airports. Taking Paris Orly Airport as an example, the scientific research facilities include a university of 34,000 students and 21 academic research labs, and seven higher-education institutions have attracted 67 biotech companies to get established here, with 60 hectares dedicated to innovative life sciences companies. Therefore, research and educational facilities have a great impact on business development, and also high-tech-based industries.

Commercial land use has not only a direct correlation with residential area and airport passengers, but also with business clusters. Because commercial land use includes hotels, restaurants and even conference space as well, it is also necessary for employees and customers from business parks around the airport. The hot spot analysis further proves that commercial land uses also commonly accompany the land use of business parks, not only as service facilities for residential areas, but also as business facilities.

Although it is clear that the airport also has cluster effects on sport and leisure facilities, especially a large number of golf and riding courts occupy larger open areas than other sport facilities. The hot spot analysis shows that the sport and leisure facilities have a certain correlation with commercial land use, as well as clusters at the edge of residential areas. However, sport facilities are more independent compared to other land uses. This may be because the urban development density around a golf court is extremely low, and visitors of these sport facilities may account for a limited number, so that most sites of sports facilities do not closely rely on public transportation such as passenger railways.

3.7 **Conclusive Summary**

Several conclusions could be summarized from above statistics and analyses of the eight case study airport regions.

First of all, the distribution of each kind of land use is shown obvious tendencies in different scope of airport regions. For example, the peak value of commercial land use proportion appears in the scope of 6 km distance to the airport. From the 6 km scope to exterior, the proportion of commercial land use starts to sharply decrease. It indicates the development potential and land value of commercial land use is the highest in the 6 km scope. The positive impact from the airport to the commercial development sharply decreases from the 6 km scope to 9 km scope. Outside the 9 km scope the airport impact is ignorable, and the commercial development potential outside the 9 km scope could be considered as the same as in common urban region. The land use distribution tendencies under impacts of distance to the airport could also be found in industrial, residential, recreation, higher education and research land use. It is significant for local authorities and planners in future airport regional land use planning, as well for investors to sitting their new commercial facilities in airport region.

Second, although there are numerous unpredictable influence factors that impact on the land use distribution, but there are still obvious relations between airport capacity (airport annual passenger number, annual cargo tonne and the number of airport stuffs). In other words, it is possible to explain land use distribution features by airport capacity as the main influence factor, and predict the land use value in certain region of a new airport. For example, an established linear regression model have been found to explain the correlation between the airport annual cargo tonne and the total area of industrial land use in the scope of 9 km distance to the airport. The similar correlation has also been found in between the number of airport employee/ annual passenger and the total proportion of residential land use in the scope of 12 km distance to the airport, as well as the correlation between annual passenger number and the proportion of commercial land use in the scope of 9 km distance to the airport. By using these established regression models, the local authorities, planners as well as investors could predict different distribution features of different land uses in airport regions, thus to avoid risks in airport regional planning and investment in airport regions.

Third, the author also takes airport location as an influencing factor, to study the relationship between airport location and land use distribution features in their vicinities.

According to resultants of GIS density analysis, three typologies summarized to explain the airport location impacts on land use distribution. They are: Airport locates in city circles; Airport locates distance to the city; Airport in city edge. Take airport locates in city circles as an example. When airport locates in a city circle, and serves not only one mega city, but also a metropolitan region with a bunch of cities, then airport-.related clusters will not only locates at the main airport-city direction, but also appears at all directions which has traffic connections from airports to different cities. Communities which on traffic linkages of the airport and these cities will be more or less impact by airport development, thus the airport impact regions larger than the other typologies. Moreover, because there is more available land for such industries to home, the total volume of airport related land use is also larger than the other two typologies. Therefore, we could conclude, when airport locates in a metropolitan region with more than one city to serve, then the airport-related facilities may have a better opportunities to develop. Controversially, when authorities and planners making future development plans for new airport regions, a development strategy which focus on diverse directions may have larger benefits than just focus on solo airport-city direction, and may enlarge the airport economic impact on a larger region.

Fourth, according to resultants of GIS hotspot analysis, in fence of airport region, different land use had shown various distribution features under impacts of airport ground linkages and airport noise. Take residential land use as an example, according to many published studies, airports have impact on residential clusters. However, the resultants of GIS hotspot analysis show the contradiction of residential land use development. On one hand, residential land use distribution must avoid the noise interference from the airport and outside the airport noise contour; On the other hand, airport has also attractions to residential land use, and certain locations close to airports may also become new hotspots of residential development. Meanwhile, when comparing localities situated in the equivalent scope of the airport, those pointing in the opposite direction of the airport noise contour will enjoy more advantages and have more opportunities for development new residential areas than localities in the same direction of the airport noise contour. Therefore, for communities within the same direction of the airport noise contour, noise risks should be evaluated cautiously before new residential area developments are planned. Such tendencies have also been found in commercial, industrial, educational and recreational land uses, which could be reference for future airport region planning.

A land use network has also been found according to GIS hotspot analysis. It shows the correlation between each land use.

4 Community of Tomorrow – An Air Front Urban Image

4.1 Significance of Urban Image in the Knowledge Economy Era

4.1.1 The Concept of Urban Image

The developer of the "Urban Image" concept is considered to be the American town-planner Kevin Andrew Lynch, who cemented the notion of city image both terminologically and conceptually in his fundamental work "The Image of the City". In relation to the analyzed concept, Lynch introduced certain notions regarding the perception of urban space: legibility and image ability[106].

The first notion expresses the degree of clarity of the urban landscape, meaning the easiness with which any part of the city can be identified, and its image organized into a coherent model. Legibility defines the degree at which a city is capable of generating a lesser or broader visual quality for the receiver subject[107].

In this sense, Lynch associates urban space to a coherent grammatically and literarily correct text, through the coherency and logic of which it is able to produce a strong feeling in the reader. Residents or passers-by must be able to similarly and easily "read" the city, as a result of the current mode of organization and planning, which means that understanding and organizing information, orientating through the urban landscape, is easy. The marks, strong visual elements, are easily recognizable, and at a mental level symbols are assimilated after a coherent cognitive structure.

The city's legibility degree depends on whether or not its image is positive or negative, a perception that, through its dimension, forms attitudes towards towns. It is natural that a city with a favorable image will always attract investors, tourists and new residents. During

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[106] Marius Cristian Neacşu, "The City Image and the Local Public Administration: A Working Tool in Urban Planning," *Transylvanian Review of Administrative Sciences*, no. 27E (2009): 172–88.

[107] Kevin Lynch, *The Image of the City*, 1ST edition (Cambridge, Mass.: The MIT Press, 1960).

the search process of the best way between places in the town, the image of urban space – the mental image generalized at an individual level, a product of both the immediate perception and past memorized experiences – becomes a reliable instrument in interpreting and organizing information that can be used in making a decision. The image of the place hereby works as guidance of the decision-making behavior. A city or a place well decrypted and understood by its inhabitants leads to a very evident image of the place, dictated by a systematized organization of the urban environment and easily decipherable, which can be a frame of reference in organizing the activity or cognition, a starting point in receiving and accumulating future information[108].

The second notion, image ability, refers to a city's quality to induce the perception of a powerful image to an external observer. This quality contributes not only with the visual perspective of the urban landscape, but also the coherent structure and the feeling of identity that the city can generate. A "good place" is the one that can be mind-mapped by individuals, with an easy-to-memorize spatial organization.

In Lynch's view, there is a correlation between the "physical city" and the "mental city", that city which is internal to the actor and external to the observer's mind. The mental city shapes or indicates a clear and positive image of the "physical city" that provides not only satisfaction to its citizens, but also lets the city have more opportunities for further development. Thus, a city's image in certain degrees predicates the future of the city.

In "The Image of the City", Lynch also presents how people perceive cities. Lynch argues that people structure their perception on cities into recurring elements, such as[109]:

1. Path, along which movement flows.
2. Edges, which distinguish one part of the urban fabric from another.
3. Districts, in which observers can mentally go inside, and which have some common character that they can recognize internally.
4. Node, which are the strategic foci into which the observer can enter, typically either junctions of the path or concentrations of some characteristic.
5. Landmarks, which are a point of reference considered to be external to the observer, are simple physical elements and widely in scale.

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[108] Marius Cristian Neacşu, "The City Image and the Local Public Administration: A Working Tool in Urban Planning," *Transylvanian Review of Administrative Sciences*, no. 27E (2009): 172–88.

[109] Kevin Lynch, *The Image of the City*, 1ST edition (Cambridge, Mass.: The MIT Press, 1960).

4.1.2 Urban Image in the Knowledge Economy Era

In recent decades there has been a growing awareness of the city's image as an impetus for innovation and regional economic growth in Europe, and similarly a growing willingness to develop strategies for urban revitalization. Increasing efforts are being made to create attractive urban spaces and to improve the urban environment in order to attract visitors, investments, workers and companies. It has become an integral part of urban and regional development strategies to think not just about the built or material infrastructure, but also about immaterial things projecting a positive image and building/maintaining a good identity or brand[110].

■ **Near Resource Is No Longer a Precondition for the Knowledge Economy Era**

Unlike modern industries, the economic growth and employment opportunities mainly rely on manufacture that is based on natural resources and materials. However, the knowledge economy is rather competitive between regions and cities as a consequence of intangible measures – the ability to attract and retain talented and creative labor, to provide interactive milieus where new ideas can grow, etc.

Traditionally, most regional and urban economic (re)development policies have focused on two key areas[111]: Firstly, they have concentrated a large amount of time and money on building up the hard infrastructure essential to functioning regions (everything from roads to cable networks). Secondly, they have focused on supporting the efforts of firms that exist in (or have recently moved to) the area. A wide range of policies for firm, entrepreneurial, sectorial and cluster support have been put in place in order to help bring out the potential of companies to innovate and compete. Indeed, both types of policy focus have had wide-ranging effects.

Whilst all these sorts of policies are obviously significant for building and maintaining urban and regional competitiveness, there is a growing awareness that such tangible measures may not be enough. With ever increasing levels of globalization and technological advances in communications and travel, it appears that both businesses and

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[110] Johan Jansson and Dominic Power, "The Image of the City: Urban Branding as Constructed Capabilities in Nordic City Regions," Nordic Innovation Center, Oct 2006

[111] Johan Jansson and Dominic Power, "The Image of the City: Urban Branding as Constructed Capabilities in Nordic City Regions," Nordic Innovation Center, Oct 2006

workers are more mobile and uncommitted than ever[112].

A clear urban image could attract business and workers efficiently. In recent years, cities such as Barcelona, Bilbao, Dublin and Manchester have shown that by changing their image and brand – or the ways in which both the outside world and their own citizens/businesses perceive the place – economic redevelopment and reinvention are greatly helped. On a wider level, writers like Richard Florida have shown that in knowledge economy, firms, creative workers and entrepreneurs are drawn to places with strong and dynamic images and brands. In a highly debated study of economic growth and business innovation in the USA, Florida shows that, in the last 50 years, the regions with the highest economic growth and innovation records are those with strong brand identities such as being open, tolerant and dynamics milieus. Even venture capital seems today to be highly susceptible to the lure of sturdy regional brands that give resident companies the mark of quality and innovation: e.g., the power of 'Silicon Valley' as a brand in motivating and attracting venture capital. This way, creating a strong regional brand makes it easier to attract not just tourists, but most significantly mobile knowledge workers, inward investment and venture capital. It may also help in building feelings of civic pride and accomplishment; this can in turn help existing firms and residents stay in 'their' place[113].

- **Importance of Creating Urban Image and Urban Branding**

In general, creating a proper urban image could be seen as a vital component in[114]:

1. Attracting investments and international venture capital
2. Attracting and maintaining companies
3. Attracting and maintaining skilled knowledge workers
4. Attracting new Citizens
5. Attracting tourists and visitors
6. Sales and marketing of locally produced goods and services

As can be seen from the above list, urban brands can help not only grant great attractiveness to the area, but also be important to how things produced in the local area

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[112] Johan Jansson and Dominic Power, "The Image of the City: Urban Branding as Constructed Capabilities in Nordic City Regions," Nordic Innovation Center, Oct 2006

[113] Richard L. Florida, *The Rise of the Creative Class: And How It's Transforming Work, Leisure, Community and Everyday Life* (Basic Books, 2002).

[114] Johan Jansson and Dominic Power, "The Image of the City: Urban Branding as Constructed Capabilities in Nordic City Regions," Nordic Innovation Center, Oct 2006

become perceived elsewhere, i.e., in export markets. It seems that more and more varieties of products and services rely, in their competitive edge, on intangible and symbolic elements such as their identity, marketing, as well as brand, symbolical and aesthetic merits. If industries such as tourism are entirely reliant on the image and brand to which an area is associated, it is also true that many manufactured products are equally sold based on regional and urban brands. An example of this is the added value that the brand "Paris fashion" gives to French clothing and luxury goods manufacturers, or which "Danish Design" gives to Danish furniture exports[115].

4.2 Reinterpretation of Urban Image for Airport-Surrounding Communities

4.2.1 Significance of Creating an Urban Image for Airport-Adjacent Communities

Urban shapes and elements create certain connections and significations in the mind of actors. The "physical city" is doubled by the "mental city". The "mental city" shapes or should indicate the dysfunctions of the "physical city"[116]. Thus, for individuals, a positive and clear image of a city is significant in evaluating whether the city is suitable for living, investing and working.

Creating a favorable urban image for airport regions has more significance, especially for localities near airports that are newly opened or still under construction. There are several reasons in explaining the importance of creating a clear image for airport-surrounding communities.

First, for local residents in airport regions, the impacts brought by the nearby airport are inevitable, especially noise impact and interference of lifestyle by new inhabitants and airport passengers. Before the airport starts operating, the incoming airport will cause a sense of fear in local residents. It could explain why there are numerous complaints and protests of local inhabitants against airport development projects. According to statistics,

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[115] Johan Jansson and Dominic Power, "The Image of the City: Urban Branding as Constructed Capabilities in Nordic City Regions," Nordic Innovation Center, Oct 2006

[116] Marius Cristian Neacşu, "The City Image and the Local Public Administration: A Working Tool in Urban Planning," *Transylvanian Review of Administrative Sciences*, no. 27E (2009): 172–88.

annual complaints and protest activities against the airport development project before it starts operating are even more than afterwards. Therefore, for local authorities and decision makers, it is necessary to outline an image of harmonious airport-front community to tranquilize local residents before an airport goes into operation, to thus retain residents and attract more inhabitants. This kind of image may also be accompanied by certain practical urban developments, which shows an attitude to minimize negative airport impacts.

Second, in community level, for potential investors and residents, a positive urban image of an airport-neighboring community is important for promoting competitiveness. Before an airport starts operating, the competitiveness in airport-surrounding localities is basically dependent on two determinants. The first is the status of environment and infrastructure for business and living at physical level. The second is the future development tendency and visions, as the urban image to convince existing and potential investors and inhabitants.

Basically, before a decision of an airport development project has been made, the competitiveness of airport-adjacent communities could be considered in the same level. None of these communities has sufficient airport-direct developments that meet the needs of a new neighborhood airport. Establishment of a positive urban image in a community gains more attractiveness in competition with its neighbors. Some localities may have a denser population or better infrastructure and service facilities than others. However, when facing great challenges from the new neighboring airport, such inherent advantages might not play a decisive role in attracting investments and inhabitants. Establishing a positive urban image may enhance the inherent advantage for such localities, and may turn inborn disadvantages to advantages for other communities. Therefore, an outlined local “mental city” authority is more significant than the current status of the “physical city”. A good and proper image accompanied by an efficient urban development strategy will be the determinant in promoting competitiveness at both regional and community level.

4.2.2 SWOT Analysis for Airport-Surrounding Communities

SWOT (**S**trengths, **W**eaknesses, **O**pportunities and **T**hreats) analysis of general opportunities and challenges of airport-surrounding localities is an important pre-phase for identifying proper development strategies. Whilst communities surrounding airports are like geographical transit positions at a regional, national and international level, so they enjoy incomparable opportunities for attracting residents, investments, companies and visitors/tourists. However, these communities also suffer the most prominent noise impacts in the whole region. Moreover, urban development and new constructions may change the

old image of these localities, thus decreasing the sense of belonging of local residents; over-sized industrial and business parks cause unacceptable air pollution and lead to worse environmental risks. Therefore, an inaccurate planning or development strategy may lead to decrease of population, investments and attractiveness to business, thus causing a reduction in competitiveness with other neighboring communities, and in this situation a SWOT analysis is extremely significant.

STRENGTHS	WEAKNESSES
• Located nearby or next to airport • Advanced accessibility to ground traffic network • Large area of reserved land available for further development	• Noise impact from airport • Noise impact from ground traffic • Air pollution and ecological risks • Lack of work force, especially skilled knowledge/specialized workers
OPPORTUNITIES	THREATS
• More jobs and employment opportunities • Population growth • Attracting and retaining companies and investments • Attracting social unds • Attracting visitors and tourists	• Integration problem between local residents and new inhabitants • Decision-making failure causing lack of competitiveness to neighbor communities in attracting investments, companies, visitors and work force

Table 4-1 SWOT Analysis of Airport-Surrounding Communities
Source: By the author

According to SWOT analysis of development opportunities and challenges of airport-surrounding localities, we could conclude that there are four determinants, namely:

1. A successful development strategy should maintain the reputation, the sense of belonging and the sense of security for both local residents and new inhabitants, for retaining the first and attracting the latter, thus generating a residents-friendly urban image.
2. A successful development strategy should be efficient in creating an open business environment, providing sufficient service facilities, thus maintaining local companies and attracting new investments and firms, generating a business-efficient urban image.
3. A successful development strategy should be efficient in attracting visitors and

tourists, creative industries and attention from the media, hence promoting its attractiveness for outside observers.

4. For creating the image of airport-adjacent communities, each of them should consider neighboring localities as both cooperative partners and competitors. A community should exert its advantages and complement with other communities, and together create a concordant regional image. In this level, communities should see their neighbors as collaborators rather than competitors. In addition, there is also competitive relationship between each community. Thus, urban image for airport-surrounding localities should be regarded at both regional and community level. A good and clear urban image for the whole airport region may promote competitiveness in a whole regional level, and communities' own images may induce competitiveness in relation to other neighboring localities.
5. Such images should be based on minimum airport negative impacts (such as noise, water and emissions) and maximum airport benefits (mobility, opportunities for economic profits), and in some points turn negative impacts into strengths.

4.2.3 The Airport Is Not Hateful, Just Noisy

It is impossible to tell when exactly airports became a worldwide target of public criticism. The development project of an airport is always accompanied by strong opposition from the public, especially from communities near airports. For example, in August 2007, the Camp for Climate Action took place within a mile of Heathrow. The camp ran for a week, and on the final day some 1,000-1,400 people protested and 200 people blockaded the British Airports Authority (BAA) headquarters. Before the camp, BAA requested the "mother of all injunctions", which could have restricted the movements of 5 million people from 15 different organizations, including the RSPB, Greenpeace, the Campaign for the Protection of Rural England, the Woodland Trust, Friends of the Earth, and the National Trust[117]. The injunction would have technically had included the Queen, the patron of the RSPB and CPRE, Prince Charles, in his position as President of the National Trust, and even some of BAA's own staff[118]. On Saturday, the 24th, thousands across Germany – perhaps as many as 30,000 – took part in protests at airports against their expansion and aircraft noise.

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[117] Brown, Jonathan, Joy for protesters as Heathrow is denied 'mother of all injunctions, London: The Independent, 08.07.2007.

[118] "BAA Wins Heathrow Protesters Ban," *BBC*, August 6, 2007, sec. UK,

At Frankfurt airport, around 10,000 people claimed for a night flight ban from 10.00 p.m. until 6:00 a.m., and a cap on the number of take-offs and landings each day. In Berlin, about 10,000 protesters gathered against the planned new Brandenburg airport. At Munich airport, over 500 people had a picnic in the terminal, protesting against a planned 3rd runway, the decision on which is due in June. There were also protests in Halle, Dusseldorf, Leipzig, Bonn and Cologne – as well as Nantes[119].

Literature shows that noise from aircrafts and from traffic going to and from airports is probably the most obvious environmental impact of the aviation industry because it is easily perceived and annoying, especially where this occurs frequently[120]. According to media reports, main protests against airport developments and expansion are based on airport noise impacts, which are the most direct negative effects from airports, not only on mental and physical health, but also on land value. Therefore, when people say no to an airport development project, the true meaning behind their claims is their rejection of airport noise, but not of the airport itself.

Figure 4-1No Aircraft Noise Over Potsdam
Source: Author's shot at Potsdam-Park Babelsberg, 07,05,2012

Disregarding airport noise, people's attitude towards airports was opposite when these first

[119] Thousands gather at German airports to protest against aircraft noise, Airport Watch, 25.03.2012, accessed September 2012, http://www.airportwatch.org.uk/?p=9035

[120] "Airport Planning Guide." Aviation Environment Federation UK, 2006. accessed on July 2013 , http://www.aef.org.uk/uploads/PlanningGuide2.pdf.

came onto the world. The airport was not only a symbol of industrial and technical revolution, but also realized the human dream of flying. Thus, the airport, as a pride of human beings, used to be much more welcomed by citizens than today. In the early 19th century, avant-garde planners and artists depicted their imagination of further cities, and most of them are related to airports and aircrafts, which are an indispensable symbol of modern technology.

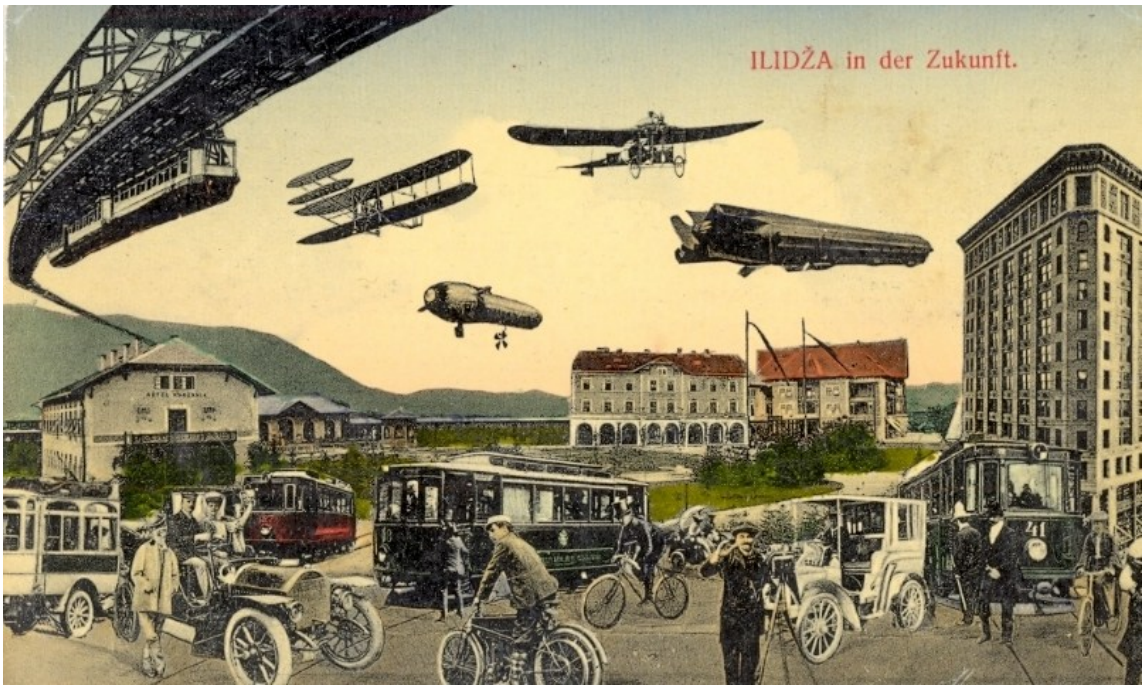

Figure 4-2 Ilidža in the future,
Source: Postcard, Koloman Oreskovic, publishing year 1909

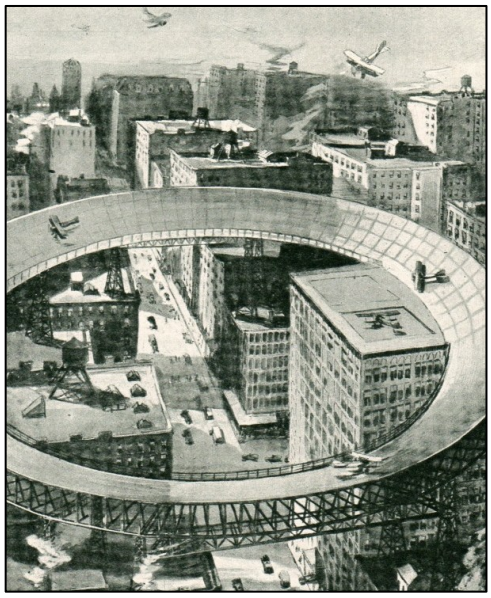

Figure 4-3 Roof Top Inner-City Circular Airport, 1919
Source: Illustrated London News, 18 Oct.1919

Figure 4-2 is the image of an old postcard released in 1909. This image outlines the imaginary city in the "future". In such image, automobiles, light rail and also airplanes are represented as symbols of modern technology. People in the image also seem pleased with aircrafts flying above their city. It was "one of the prettiest places on the Earth", as E.B. Lenin wrote in 1894 in The Contemporary Review.

Figure 4-3 is an imagery of an Illustrated London News article (On the Impulse to Fly Commercially, 18 October 1919). The aim of the imagery is a solution for the growing popularity of commercial aviation for business and pleasure. Regardless of whether the planning is realistic or unreasonable, the image shows the popularity and ideal

of aviation at that time.

Regarding airport archaeology and landscape, Le Corbusier, high priest of the Bauhaus, declared in the 1930s that “The beauty of an airport is in the splendor of wide open space”. “Nothing could compete with the airport itself, and thus the only appropriate architecture was one that was practically invisible: just sky, grass and concrete runways.”[121]

Contemporarily, without noise impact, the landscape of the airport is also acceptable or even welcomed by the public. For example, Berlin Tempelhof airport, which is situated in the south-central Berlin district of Tempelhof-Schoeneberg and is one of Europe’s three iconic pre-WW II airports, ceased operating in 2008 in the process of establishing the Berlin Brandenburg Airport as Berlin’s sole commercial airport. In August 2009, Berlin city officials announced that Tempelhof would be opened in May 2010 as a city park. The city will spend an estimated 60 million Euro in developing the park from 2010 to 2017[122]. On the weekend of 8-9 May 2010, the outfield was festively opened as Berlin's largest public park named “Tempelhofer Freiheit”. More than 200,000 Berliners visited the park to enjoy its wide-open spaces for recreation ranging from biking and skating to baseball and

Figure 4-4 Berlin Music Festival 2013 at Berlin Tempelhof Airport
Source: http://www.cross-innovation.eu, accessed on 25.11.2013

[121] L'architecture et les aéroports modernes, in oeuvre compléte, 1938-1946, ed, Williy Boesinger 190-191,les éditions d'architecture, 1946. 190-191

[122] "Tempelhof to become an enormous city park", The Local, August 31, 2009, Accessed on August 2011, http://www.toytowngermany.com/lofi/index.php/t147684.html

kiting. The place is also used for hosting many sports, music and fashion events, such as the first Berlin Music Week, Bread & Butter fashion trade show and Berlin Marathon fair.

The real estate development and urban revitalization surrounding the Tempelhofer Freiheit is also remarkable since the Tempelhof airport permanently stopped its operations. In the period from 2000 to 2009, the districts of Friedrichshain-Kreuzberg, Neukoelln and Tempelhof-Schoeneberg indicated population increases ranging from 1.5 to more than 5%. In this context, with 7.5%, Friedrichshain-Kreuzberg indicated the second-highest population increase of all Berliner districts (whereby in segments of certain individual planning spaces, an increase of up to 20% was achieved). Yet, in the central districts, the available residential units are already sufficient to meet the demand. To warrant an attractive range of residential spaces in easily accessible downtown locations, the Tempelhofer Freiheit – with a residential construction potential of up to 4,700 units – is designed to play a significant role in this process[123].

Figure 4-5: Urban Spatial Planning of Tempelhof Freiheit
Source: Tempelhof Projekt GmbH, www.tempelhoferfreiheit.de, accessed on 25.11.2013

Although there are worldwide public protests against airport developments, an airport itself is neither ugly nor annoying. When airports first came onto the world, their role was to be a symbol of technology revolution and science innovation. The airport itself as an archaeology and landscape element of a city is also applauded by architects, planners, and even citizens. Contemporarily, if airports eliminated their noise impact on surrounding

[123] Residential Construction on the Outskirts of Tempelhofer Feld, Tempelhofer Freiheit, accessed on 05.07.2013, www.tempelhoferfreiheit.de.

communities, such as Tempelhof in Berlin, they would also be easily accepted by local citizens. Therefore, conclusions could be drawn, such as:

1. Noise from airports is the most obvious influencing factor that arouses protests of the public against airport developments. Urban development strategies based on reduction of airport noise impact are a key solution to change local residents' attitude towards nearby airports, from a target of criticism to a friendly neighbor of the public, or at least becoming accepted by local residents.
2. By creating a clear and good airport image based on reducing airport noise impact, enhancing the airport identity may not only work on decreasing public protests and attracting new inhabitants. It could also enhance a sense of pride and honor for local residents, and also attract media and tourists, thus promoting business and investment opportunities at a regional level.

4.3 **Integrated Urban Design Approach**

According to the last chapter, noise is the most serious challenge for urban development of communities in airport regions. The main noise sources are commonly considered to be airplanes, industry and ground traffic. The primary task for urban development of airport-surrounding localities is to reduce the noise impact on local residents, in order to retain residents and attract new ones. In the planning and architecture design region, reducing airport noise should mainly focus on four passive noise protection strategies, as shown in Figure 4-6, and the approaches could be seen on Table 4-2.

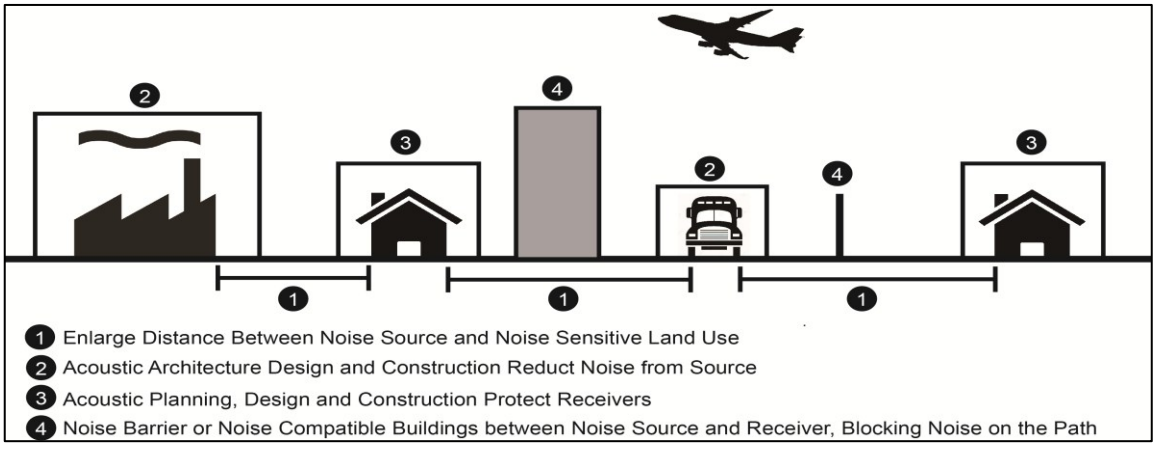

Figure 4-6: Passive Noise Protection Strategies
Source: By the author

Methodology	Approach	Effect	Cost	Comments
Site Planning	Distance between Noise Source and Receiver ▪ Placing Noise Compatible Land Use as Buffers ▪ Orienting the Residences away from the Noise	Good-Excellent: Depends on Size of Lot and Natural Terrain	Low	Inexpensive, Require Space, Limited Sound Reduction, Positive Aesthetic Impact
Architecture Design	▪ Room Arrangement ▪ Deaf Walls ▪ Balconies and Sound Curtain ▪ Courtyards (exterior)	Fair	Low	Low Cost but Limited Effectiveness
Acoustical Construction	▪ Sound Isolating Walls, Windows, Doors, Ceilings, Floors ▪ Interior Design ▪ Masking Another Way	Excellent for Interior, Poor for Exterior	High, especially after Construction	Most Effective Noise Reduction for Interior
Barriers	Slope of Mounds of Earth	Excellent	Depend on Availability of Earth	Good Noise Reduction and Aesthetic, Require Space and Maintenance
	Walls and Fences	Good	Depend on Height and Thickness	Require Little Space, Aesthetically Unappealing
	Planting	Poor	Depends on Size of Buffer Strip	Poor Noise Reduction but good Aesthetic Appeal

Table 4-2: Planning, Architecture Design and Construction Approaches for Airport-Surrounding Communities

Source: By the author

As for urban planners and architecture designers, the above noise protection measures should not be considered only as a technological solution just for noise isolation, but should also integrate with aesthetical, functional and spatial meanings, and base on noise protection purposes to develop high-quality architecture design and urban spaces, as well as endow the meaning of urban image and branding. The approaches may be realized through proper plans and designs of five main factors (path, edge, district, nodes, and landmarks), which are components of an urban image.

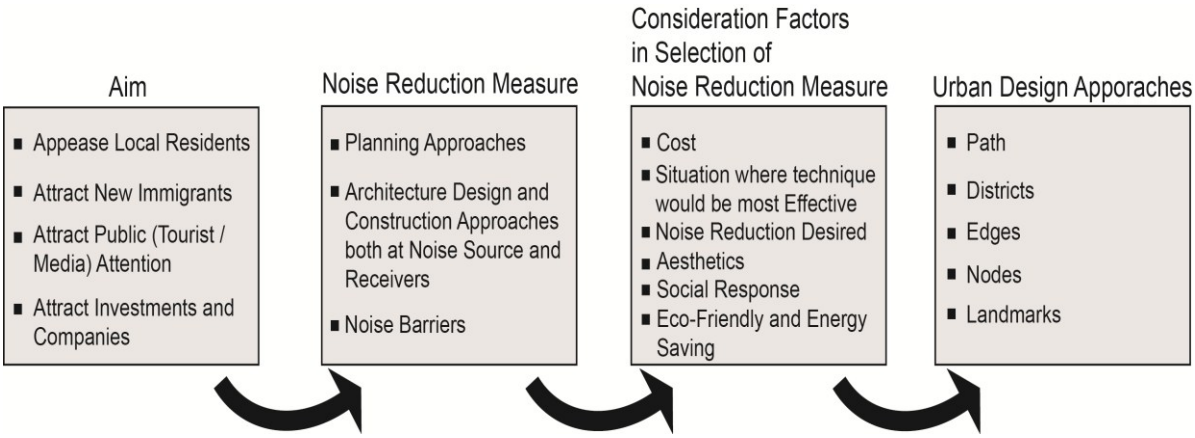

Figure 4-7: Planning, Architecture Design and Construction Approaches for Airport-Surrounding Communities
Source: By the author

4.3.1 Path &Edge

■ "Path" and "Edge" in Airport-Surrounding Communities

According to Kevin Lynch, the path in urban image could be described as "channels along which the observer customarily, occasionally, or potentially moves. They may be streets, walkways, transit lines, canals, and railroads. For many people, these are the predominant elements in their image"[124]. Further, Lynch added that "The potential drama and identification in the highway system should not be underestimated"[125].

"Edge" in Kevin Lynch's word consists of "linear elements not used or considered as path by the observer, they are the boundaries between two phase, linear breaks in continuity: shore, railroad, cuts, edges of development, walls. They may be seams, lines along which two regions are related and joined together"[126]. He also indicated that "These edge

[124] Kevin Lynch, The Image of the City, 1ST edition (Cambridge, Mass.: The MIT Press, 1960).

[125] Kevin Lynch, The Image of the City, 1ST edition (Cambridge, Mass.: The MIT Press, 1960).

[126] Kevin Lynch, The Image of the City, 1ST edition (Cambridge, Mass.: The MIT Press, 1960).

elements, although probably not as dominant as paths, are for many people important organizing features, particularly in the role of holding together generalized areas, as in the outline of a city by water or wall"[127].

In the selection of "path" and "edge" when looking for planning solutions for creating an urban image based on noise reduction, the "path" could be considered as the traffic corridor, such as railway and highway through airport-adjacent localities, and the edge could be considered as the gray space between the traffic corridor and the urban space.

It is no doubt that the site of the airport should have a certain distance to the connected city as well as an advanced ground traffic network serving airport passengers and freights from/to the airport. After the airport starts operating, local residents living in airport-neighboring communities may suffer greater noise impact from ground traffic connections than other suburban regions. Ground traffic linkages may at times serve heaver traffic flows under the impact of the airport. Therefore, ground traffic noise is considered as the secondary influencing factor for airport-surrounding communities. In some cases, noise impact from ground traffic is even more obvious than the airport itself. Therefore, they should be considered as the "path" and "edge", and the noise impact from such "path" and "edge" should be first taken into account, so as to retain local residents.

Second, large urban spaces along traffic corridors are considered as negative or gray spaces in planning, and the "edge" of residents' activities. In airport-adjacent localities, dense ground traffic infrastructure not only has a negative visual and aesthetic impact on local residents, but may also hinder economic development and decrease local housing prices. Moreover, when countless immigrants move into communities after the airport starts its activities, this kind of land may even cause social insecurity. Therefore, urban design approaches that transform such "edge" from negative into positive urban space are urgently needed.

Third, for airport-neighboring localities, a determinant of urban development success is whether the community could promote its image, thus attracting new inhabitants, investments and firms. However, the optimal place for catching the attention of airport passengers, tourist and commuters is not inside the community, but on highways and railways that visitors pass through. Therefore, creating an impressive urban image along the "path" and "edge" that integrates noise reduction is also important for promoting

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[127] Kevin Lynch, *The Image of the City*, 1ST edition (Cambridge, Mass.: The MIT Press, 1960).

community's competitiveness by catching passengers' attention.

There are several integrated urban design approaches in controlling ground traffic noise by reducing it along the path. Adding noise barriers or buildings/structures for compatible land use along the corridor could be considered as two of the most effective measures.

- **The Noise Barrier**

Regarding highways in airport regions, on the one hand accessibility and connectivity have been greatly improved by highways. On the other hand, the highway as a visual and spatial barrier breaks the integrity of the urban landscape. No matter if walking beside the highway or driving on it, for both pedestrians and drivers it will not be a good experience. Indeed, the repetition of a simple, strong and consistent form can be visually powerful, but annoying.

Noise barriers, as effective tools for reducing highway or railway noise along the urban region, have certain advantages, such as occupying little space and reducing noise, being broadly used in isolating highways and railways from noise in urban regions. Therefore, a noise barrier is also an effective tool for airport-surrounding localities to reduce ground traffic noise impacts from highways and railways.

Noise barriers are considered as a part of the road structure and designed based on technical concerns. Thus, noise barriers enhance the negative visual impact of highways. However, well-designed roadside barriers, which are regarded within the urban context, may not only represent urban identities, but also provide delightful visual and emotional experience for both highway users and local residents. Therefore, a well-designed noise barrier should take into account both the road user's and the protected side, and the design requirements for these two sides are quite different.

In road users, overly simplified visual experience may induce monotony. An integrally designed road barrier at the edge of a community's border or inside the community may not only inform the road users about the place they are arriving at or passing through, but also delight road users by an impressive visual experience, making them fond of the community. Barriers from the driver's view should also reflect the character of the locality through which the road passes, in order to provide a sense of place, thus avoid blocking significant views of the surrounding area, both towards and from the road. However, if lengthy barriers are necessary, the designer should apply appropriate design concepts to add visual interest in order to avoid a monotonous appearance. Figure 4-8 is a noise wall project which was used as a perimeter wall to a new development. All the panels were

hand-painted by local artists to represent the locality. Figure 4-9 is a highway noise wall concept design by "bread studio" architects. The noise barrier takes the form of acoustic foam, the perforated material with modulated surface that helps break down and absorb sound. Also a vegetation infill, which takes up half of the area, is present and made of recycled plastic to reduce the structural burden of the steel frame. At last, it provides a unique view and breaks the visual monotony for road users.

Figure 4-8 Noise Barrier Representing a Locality
Source: http://www.modularwalls.com.au/

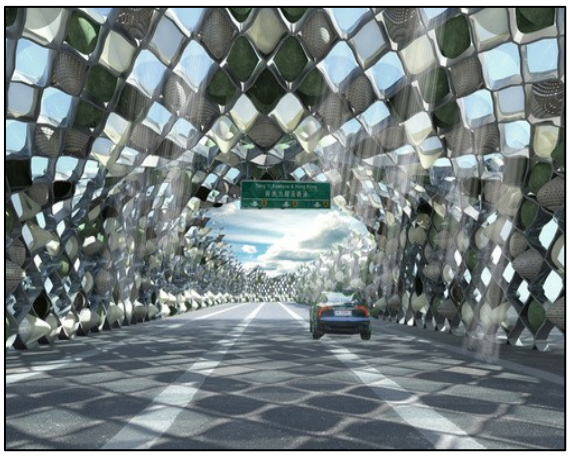

Figure 4-9 Noise Barrier Breaks the Monotony for Road Users
Source: bread Studio Architects

In highway design, from a road user's perspective, a highway exists in time as well as space. A driver neither views a highway at any particular point in time, nor indeed from any one point of observation. Instead, the highway is experienced through what Simonds described as a flow of impressions: "When in motion, one sees a series of images blending into an expanded visualization of an object, space or scene. This becomes even more significant when one considers the speed at which the experience occurs. At 40 km per hour detail may still be relevant, but at 110 km per hour what is important to the viewer is an overall impression rather than the detail"[128].

Figure 4-10 Vivid Urban Activity Behind a High "Wall"
Source: By the author

[128] Johnson Walker, *Noise Wall Design Guideline- Design Guideline to Improve the Appearance of Noise Walls in NSW* (RTA Major Infrastructure Directorate Australia, ISBN 9781877070037, 2006).

In order to protect residents against highway and railway noise, in the planning level highways should be built with certain distance to residential areas. However, with an irresistible trend of expansion of airport-surrounding communities, highways will inevitable be adjacent to residential areas. For local residents, non-human scale, technique-based highways not only break the continuity and integrity of the urban space, but also provide an unaesthetic visual impression. Thus, not only highway and railway themselves, but also their surroundings are commonly seen as "gray space" in urban development. However, not all large-scale, high visual barriers play a negative role in the cities. When it is well concerned with the urban context and urban image, a "wall" may also become a positive space and attract resident's activities (Figure 4-10).

Figure 4-11: A Noise Barrier Design with Urban Context Transforms Negative Space Into Positive Space
Source: ESKYIU Architects

Designers can provide a barrier which minimizes this potential intrusion by using attractive materials, which display in plan and elevation. Vegetation incorporated within the barrier design will soften its overall impact by imparting a more natural character and relieving the monotony of a horizontal skyline[129].On the residents' side, a character of the neighborhood should be looked into to provide a checklist of its distinguishing elements. For example, in the urban context, the design of barriers needs to capture something of the neighborhood, such as the prevalence of a particular material or style in building. For a green suburb, a barrier incorporating plants might blend in more readily. In turn, the design of a barrier near a point such as a group of high-rise blocks might best echo their visual dominance.

[129] *Guidelines on Design of Noise Barriers* (Hongkong: Enviromental Protection Department, January 2003).

■ Building and Urban Development Project

Noise-compatible or less noise-sensitive building could efficiently reduce noise impacts on it hinterland. Whenever possible, such land use should be located along the highway and railway in order to protect the residential units and public space. In addition, noise protection could be achieved by arranging the site plan to use buildings as noise barriers. A long building or a row of buildings parallel to a highway or a railway can shield other more distant structures or open areas from noise. One study shows that a two-story building can reduce noise on the side of the building away from the noise source by about 13 dB(A)[130].

When an airport-adjacent community faces urban expansion driven by nearby airport impacts, the land use in this region may become denser, and former rural places will also be replaced by residential units and commercial and industrial facilities. Therefore, not only commercial and industrial land use will originate clusters along the traffic corridor, but also residential land use may become denser than before. Thus, an integral land use plan that arranges more noise-compatible land use at the front, and noise-sensitive land use at the back, is a good solution for airport-neighboring communities against noise in high-density urban district planning.

Furthermore, the place of airport-surrounding localities being visited by airport passengers and commuters is not the inner space of the community, but rather alongside traffic corridors. Well-concerned buildings along traffic corridors may not only let passengers reduce traveling stress and monotony, but also recognize the space and take interest into it. Buildings along traffic corridors for airport-adjacent communities are like show windows on a shopping street. An eye-catching show window could delight pedestrians and entice people to walk into the shop. Well-designed buildings or urban development projects may also attract tourists, potential investors and potential inhabitants' interests, thus promoting the competitiveness of the community. Therefore, when long and continuous buildings along traffic corridors are decided to be necessary, they should not be seem just as a noise barrier, but also considered as representatives of the community's identity.

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[130] Highway Traffic Noise, Department of Transportation of U.S , , accessed 30.November.2012, http://www.fhwa.dot.gov/

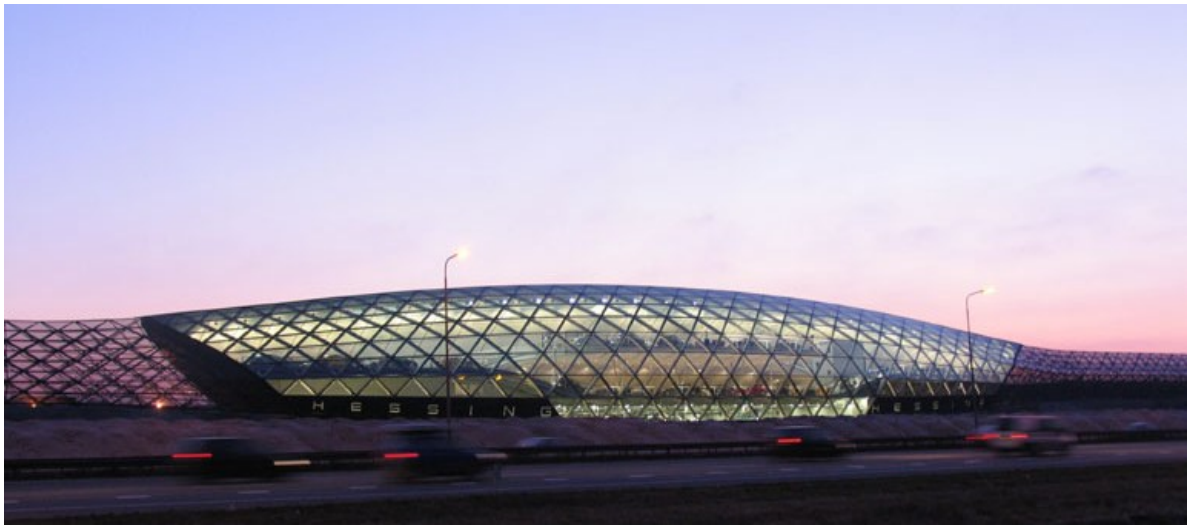

Figure 4-12: Noise-Compatible Buildings as Both Noise Barriers and Land Mark - 2005
Source: Architect: ONL Oosterhuis_Lénárd, http://www.oosterhuis.nl/

Figure 4-12 is a good example to explain that a noise-compatible building could be used as both a noise barrier and a landmark for an urban region. The project is situated along the A2 highway from Amsterdam to Maastricht. It includes in its 1.5 km a car showroom for Hessing, a seller of high-end luxury and sports cars. Their design corresponds to the speed of movement through a streamlined shape that gradually changes in plan and section across its length. The designer, ONL architects, also named the design as "Sixty seconds of architecture[131]" to illustrate that this works both ways, especially at night, when the illuminated showroom is noticed by those road users rushing by at 120 kmh.

4.3.2 Nodes

In "The Image of the City", Kevin Lynch defined that "Nodes are points, the strategic spots in a city into which an observer can enter, and which are the intensive foci to and from which he is traveling. They may be primarily junctions, places of a break in transportation, a crossing or convergence of paths, moments of shift from one structure to another". He also stated that "Although conceptually they are small points in the city image, they may in reality be large squares or even entire central districts when the city is being considered at a large enough level"[132]. For an airport region, nodes could be considered on two levels,

[131] The design specification of "Hessing Cockpit", ONL Architects, , accessed on 01 December 2013, www.oosterhuis.nl

[132] Kevin Lynch, *The Image of the City*, 1ST edition (Cambridge, Mass.: The MIT Press, 1960).

explained next.

■ **"Nodes" on Communities Level**

On community level, nodes could be defined as railway stations and highway joints. Because they are "junctions, places of a break in transportation, and a crossing or convergence of paths. Decisions must be made at such junctions, people heighten their attentions at such places and perceive nearby elements with more than normal clarity. This tendency was confirmed so repeatedly that elements with more than normal clarity"[133]. When "path" is a railway and highway corridor, and considered as show windows of a community, "nodes" could then be explained as entrance of the community, which provides the first impression to people entering it.

According to hot spot analysis of land use clustering, except for the airport itself, the most obvious urban land use clusters are commonly found around railway stations in case study cities. These clusters include not only commercial or industrial units, but also residential ones. Indeed, railway station is considered as a positive strength and has commonly been arranged to be an engine to promote a district's revitalization. A well-operated railway station business circle may not only attract tourists and potential investors' interests, but also residential units' creation in walking distance to shops, schools and other services. Hence, "nodes" as train stations must be well considered in future communities' urban plans.

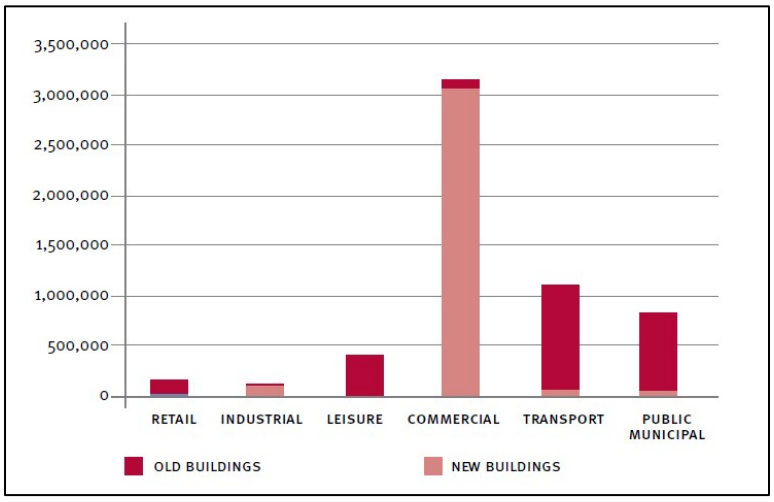

Figure 4-13: Change in Ratable Value in Railway District of (£), 2003 to 2008
Source: VOA; Sheffield Rating List 2005, 2010

[133] Kevin Lynch, *The Image of the City*, 1ST edition (Cambridge, Mass.: The MIT Press, 1960).

Lee Young-Sang stated that[134] "Railway stations are gradually becoming the center of the residents' living by not only having the function of service and traffic, but also developing commerce facilities with high density". Further, Shin Yekyeong said that[135] "Actively connecting tourism factors within the region with the railway station, by building the transfer system central to the railway station, it is increasing the number of railway passengers, thus creating the effect of the district's revitalization and increase of floating population". Brand Sands also indicates[136]that "The development effects of rail stations are most clearly associated with a strong regional economy and good links with other transportations modes, especially rail links to the local city center and public sector support of development. The presence of these factors can help provide the formation of significant development activity around stations catering to the information-exchange sector, such as offices and hotels, the stimulation of retail activities in the area, and increase in overall land value of approximately 20 percent". In a study report on "The value of station investment"[137], railway stations contribute to local economy in six ways, namely providing connectivity, providing capacity for growth, supporting sustainable economic growth, acting as gateway, offering development opportunities, acting as a commercial or community center. According to the studies above, railways should be considered seriously for urban development of airport-surrounding communities.

Several factors are needed in evaluating the potential development it brings to its host city. In their paper[138], Nakamura and Ueda concluded that there are three principal conditions needed for growth in a region: a high incidence of "Information Exchange Industries" (business service, banking service, real estate); sufficient opportunities for higher education (universities); and good accessibility to express railway stations. They concluded that there were conditions that could limit regional growth, most notably a large share of commodity-producing industries (manufacturing), and a large population of citizens over the age of 65. Brand D. Sands has also indicated in his paper[139], that the French TGV was

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[134] Lee Yong-Sang, A Study of Funciton in Japan's Rail Station after the Rail Privatization*, Journal of Asia*, .April 2011, pp. 79-99

[135] Yekyeong Shin, "The Characteristics of Rail-Integrated Urban Regeneration Focused on Japan's Local Cities," 2014

[136] Brian Sands, *The Development Effect of High-Speed Rail Stations and Implications for California*, California High Speed Rail Series (Berkeley: Institute of Urban and Regional Development, University of California at Berkeley, April 1993).

[137] *The Value of Station Investment-Research on Regenerative Impacts* (London, UK: Steer Davies Gleave, November 2011).

[138] Nakamura, Hideo and Takayuki Ueda, *The Impacts of the Shinkansen on Regional Development*, Present in the Fifth World Conference on Transport Research, Yokohama, 1989

[139] Brian Sands, *The Development Effect of High-Speed Rail Stations and Implications for California*, California High

the only factor considered by businesses in the decision to settle in a town or city. Other important factors included the profitability of the company, proximity to the market, the complete transportation network and public sector assistance.

There are also many successful urban development examples based on the opportunities that are brought by a well-arranged railway station.

One good example could be the city of Lyon. Because development in Lyon's traditional downtown is constrained by rivers, Part-Dieu (new railway station of Lyon) was promoted as part of a standing policy by local authorities. As a result, the area around the TGV station is now the most sought-after location for office space in Lyon: It has almost 40% of the city's total office space, and in 1990 it had 60% of the city's planned office projects. From 1983 to 1990, office space around the TGV station rose from 175,000 m^2 to 251,000 m^2, a total increase of 43% and an annual increase of 5.2%. According to local property agents, there are four factors responsible for the strong growth: easy access to and from the station on foot; convenience for customers; a steady flow of businessmen through the district; and high visibility of the firm from the TGV trains[140].

Figure 4-14 Bird-Eye view of Lyon Part-Dieu Station and Surroundings
Source: Bing Map, www.bing.com

Based on the previous observations, it seems that the impact of the TGV is restricted to a relatively small area of Lyon near the station, and is limited thereof mainly to advanced

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Speed Rail Series (Berkeley: Institute of Urban and Regional Development, University of California at Berkeley, April 1993).

[140] *Rail Link Project: A Comparative Appraisal of Socio-Economic and Development Impacts of Alternative Routes* (Reading: Pieda, 1991).

service firms that require good access to Paris. It also seems that much of the new development is leased to firms that have simply relocated from the traditional downtown. Moreover, it has been suggested that much of the economic activity has been the result of joint ventures between the public and private sector, in the form of financing for construction and redevelopment[141].

Railway stations could also bring great opportunity to smaller-scale urban regions. One year after the TGV Atlantic put Le Mans only 55 minutes from Paris, the city of Le Mans already had an active and diverse development program to promote the area around the station. The new station built to the south of the tracks has been integrated in a business center built on industrial and railway brown fields. "Novaxis Center", launched as early as 1986, was developed by a planning office associating all the local authorities. The business center with 10,000 m^2 had already leased half of its space to an insurance company, 2,000 m^2 to the local economic development agency for new industry, and 2,600 m^2 to the second-largest dairy company in France. By the end of 1991, an additional 22,000 m^2 had been provided. A technology center is also planned near the existing university and has already attracted the European Institute of the Musical Profession, with 350 trainees. The Institute chose Le Mans in part because of the TGV, but also because of a new highway linking it in 1996 with Belgium and the rest of northern Europe. The business center, which currently groups 80 companies and employs 2,500 people, was developed in two phases[142].

The first stage was based on the establishment of local companies looking for new buildings to extend their activities. In the second phase, the quality of real estate supply and the reduced travel time towards Paris (only 55 minutes) attracted tertiary firms from Paris to the "Novaxis Center"[143]. Its success rests on several elements: an early mobilization of local authorities through development strategies adapted to the potentialities of local economy, a diversified real estate supply of good quality and an efficient accessibility. The station area has not only asserted itself as a major tertiary pole of the city, but also constitutes a complete urban planning operation. The business center has been complemented by residential programs and infrastructures. The operation also

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[141] *Rail Link Project: A Comparative Appraisal of Socio-Economic and Development Impacts of Alternative Routes* (Reading: Pieda, 1991).

[142] Valérie Facchinetti-Mannone, "Location of High Speed Rail Stations in French Medium-Size City and Their Mobility and Territorial Implications," *City Futures 09*, 2009

[143] Valérie Facchinetti-Mannone, "Location of High Speed Rail Stations in French Medium-Size City and Their Mobility and Territorial Implications," *City Futures 09*, 2009

allowed to reduce the barrier effect due to the railroad and to reintegrate the formerly forsaken districts located south of the railroad into urban spatial dynamics. General economic indicators are also very strong in Le Mans: The number of transactions of raw land and building sites doubled in three years, land prices rose from \$892 to \$1784/m^2 in four years, and apartment prices rose from \$103 to \$195 in three years. However, the TGV is viewed as a catalyst of the development and economic activity, not its main cause or even a critical element[144].

Figure 4-15: Bird Eye View of Le Mans Railway Station and Surrounding Urban Development
Source: Bing map, www.bing.com

Planning railway stations well can ensure that they provide substantial benefits to their adjacent communities rather than causing severance or other problems. Pre-planning and integrating land-use, transportation and urban design allow the development of new railway stations, which are catalysts for new urban development areas, linked to roads, highways and regional rail. This approach requires comprehensive in-depth planning of conurbations at the edge of existing cities to link new interchanges to existing towns and city centers. Architectural designs for these were developed and peer-reviewed by a design review panel to ensure that designs achieved the clients' vision. Advantages of the comprehensive planning and design approach adopted on the railway included commercial benefits, transport benefits and opportunities for urban redevelopment.

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[144] *Rail Link Project: A Comparative Appraisal of Socio-Economic and Development Impacts of Alternative Routes* (Reading: Pieda, 1991).

An example to explain how station design and station district surrounding planning leads to urban revitalization is the Gare do Oriente (Orient Station) in Lisbon, by the Spanish Architect Santiago Calatrava. The site of the project was at Parque das Nações (Park of the Nations) and only 2.5 km to the Lisbon airport, so that it could be considered as an airport region revitalization project combined with the 1998 World Expo. The construction of the station was finished in 1998. The station has a Lisbon metro station, a high-speed, commuter and regional train hub, international bus station, a shopping center and a police office. The project, including a metro station, the underground car park and the underground gallery, posed a challenge at various levels – in terms of town planning and architecturally – as it includes two new avenues created in order to connect the station to the city and also an adjacent square which intends to accentuate and make the most of the longitudinal axis of the building. This multimodal platform centralizes transport structures for the different transport systems, which will serve the whole intervention zone and much more. There are five main nuclei, each corresponding to the various systems, especially the train station.

Figure 4-16 Shopping Mall in Gare do Oriente Station
Source: By the author

Figure 4-17 Gare do Oriente Station and the Station District
Source: Bing Map, www.bing.com

The station of Gare do Oriente, combined with the Lisbon airport and the World Expo 98' has brought opportunities for the redevelopment of its region. Nowadays, the region has been developed from a low-density rural area to a popular urban district with high density of business, education and recreation possibilities, and with a large number of tourists each year, thus constituting a new core for the city's revitalization.

■ "Nodes" on Regional Level

On a larger scale, airport-surrounding localities themselves or large urban development projects within airport regions could also be considered as "nodes" of the whole in a regional version. Airport-adjacent communities are commonly located in suburbs, with more available reserved land for development. It also has good connections with not only airport, but also with a ground traffic network as inborn advantages. Unlike railway stations that provide first impression and branding for communities, such "nodes" provide first impression and urban identity for the city and the whole region, so that promoting the whole urban image of these nodes is not only significant for local communities, but also for the whole regional economy.

There are several factors that need to be considered for such a development project or "urban branding". First, there is a difference in the number of stakeholders and their related interests; branding a community or a project may consider the complex web of preferences. Second, it is a hard task to negotiate a legitimate local value base with local participation. Third, branding a city or a place usually has to follow the paths of existing notions or historical identities of a place. Fourth, the consumers of an urban branding project are often more diverse than the consumers of a product, since urban branding has to serve diverse groups of potential investors, residents and tourists. In such situation, these "nodes" may greatly change the image of the community, and the whole community may be considered as one part of the "urban branding".

A good example in establishing regional "nodes" in airport-surrounding localities for a regional level branding could be the "Europa City" in Paris, near the Charles-de-Gaulle airport. The project location was determined to be in the northern suburbs outside of Paris, in the Triangle de Gonesse. It also falls along the route from the Charles-de-Gaulle airport to Paris, and is therefore an area that attracts a heavy amount of traffic. The site is also a cross of the RER (Regional Express Rail) and Highway A1. The creation and implementation of Europa city will take place as part of a wider development known as the Triangle de Gonesse urban project or the Triangle de Gonesse development project. The Europa City is set to be the "largest cultural, commercial, and leisure destination in Europe"[145].

[145] Website of Europa City, accessed on 10.September.2013, http://www.europacity.com/accueil/bienvenue

A Danish architecture firm, BIG has been announced as the winner of a promoted international competition for the design of Europa City (Figure 4-18), an 800,000 m^2

Figure 4-18 Bird Eye View of "Europa City"
Source: BIG Architects, www.big.dk

cultural, recreational and retail area. Combining city development with an open landscape, Europa City creates a dynamic center of activity for visitors and residents, appealing to the variety of functions of city life. It is situated at the route from Charles-de-Gaulle Airport to Paris, and has a wide range of programs that are part of a larger initiative to attract international tourism into the northern parts of Paris.

The project, visible as a massive earthwork, promises plazas, artificial ski slopes, retail establishments and recreational areas that are hidden under an expansive topography of a landscape-covered roof. The landscape is a lush and accessible green roof that undulates with the varying heights of the buildings below – which are dictated by local zoning laws – and includes slices penetrating into the levels below. The design indicates an overlap of functions – layers that are stacked and split reveal a dynamic combination of open walkways, expansive green spaces, a golf course, an integrated transit system, and indoor retail space that are stepped back and open to plazas and walkways. According to Bjarke Ingels, these walkways are designed to imitate the intimacy of Parisian streets and street life. Visual intersections between all of these programs throughout the site make it both a space of relaxation and high excitement[146].

[146] BIG Wins Europa City Development in Paris, Archidaily, accessed on 05.January.2014, http://www.archdaily.com.

4.3.3 Landmarks

■ **Concept and Significance of "Landmarks"**

In his book "The image of the city", Lynch indicated[147] that "landmarks are another type of point-reference, but in this case the observer does not enter within them, they are external. They are usually a rather simply defined physical object: building, sign, store, or mountain. There seems to be a tendency for those more familiar with a city to rely increasingly on systems of landmarks for their guides to enjoy uniqueness and specialization, in place of the continuities used earlier". He also states[148] that "A tendency also appeared for the people who knew the city best of all to rely more upon landmarks and less upon either regions or paths". Further, "Landmarks became more easily identifiable, more likely to be chosen as significant, if they have a clear form; if they contrast with the background; and if there is some prominence of spatial location".

According to Lynch's theory, landmarks are significant to provide an impression for outside observers (media, tourists, potential investors, etc.) and also in reorganizing the urban fabric for local residents. According to Brand D. Sands[149], city's identification is an important factor considered by businesses in the decision to be located in a town or city; thus, a clear landmark system should be rearranged or established in an urban revitalization plan.

Landmark in this study is defined as iconic buildings and built infrastructure. Iconic buildings are an approach to marketing and advertising places that has a long and proven history. For example, when an outside observer talks about the city of Cologne, Paris or Beijing, they are first reminded of Cologne's Cathedral, the Eiffel Tower of Paris, and the Chinese Forbidden City. By accident and by design, various places have managed to create buildings that capture the imagination to such extent that they become the most powerful symbol of what the place stands for. Some buildings, like the Twin Towers, may even be destroyed or disappear, but they retain their symbolic meaning today. Such buildings have managed not only to become icons, but also act as magnets for investments, tourists and laborers, thus a "brand" or a "logo" of a city.

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147 Kevin Lynch, *The Image of the City*, 1ST edition (Cambridge, Mass.: The MIT Press 1960).

148 Kevin Lynch, *The Image of the City*, 1ST edition (Cambridge, Mass.: The MIT Press 1960).

149 Brand D.Sands, The Development of Effects of High-Speed Rail Stations and Implications for California, California High Speed Rail Series Working Paper, April, 1993

Recently, signature or iconic buildings have gained increasing popularity among policy-makers and urban developers. Many cities have adopted a conscious strategy of using signature buildings and architecture to advertise and re-brand their cities. Architecture plays an important role in urban regeneration projects, and place marketing and in this sense architecture become a form of advertising. According to Grilley[150], "architecture is an integral part of the incorporation of cultural investment and policy into urban growth strategies, as cities struggle to attract inward investment. Architecture, from new science parks to new opera houses, is thus mobilized to transmit a catchy image of urban vitality".

However, the idea of the iconic or signature building have been questioned and criticized by several pundits. The main critique of their current popularity is aimed at the difficulty of creating a truly iconic or unique building in a world that is increasingly full of them[151]. Therefore, there are four factors in architecture design or urban design level for creating urban image by devising iconic buildings. First, the design should be considered with the urban context, such as heritage, historical and artistic resources together, this way creating the iconic building with clear local identification. Second, the design should be in accordance with the city's future development planning, thus conceiving the iconic building to stand for the future image of the city, and defining a scope of industries that will be attracted to the city. Third, if it is possible, an iconic building should be coupled with the use of events, such as trade fairs, cultural festivals and exhibitions. Fourth, the cost-benefit estimates should be consciously made before the project is started.

There are also three determinants in selecting the site for iconic buildings. The places should either have a good business environment, such as the Grande Arche in la Défense, in Paris, or a clear local identity that attracts tourists, such as the redevelopment project of the Humboldt-Forum – the Old Prussian Palace located in Berlin's Museum's Island. Else, it should be a place that lacks strength for development but urgently needs to be revitalized, such as the Millennium Dome on the Greenwich Peninsula of London.

- **Large-Sized Iconic Building as Landmarks**

A large-sized iconic building could indeed attract public attention, promote urban identity,

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[150] Crilley D, "Architecture as advertising: constructing the image of development", in Selling Places: The City as Cultural Capital, Past and Present Eds G Kearns, C Philo (Pergamon Press, Oxford, 1993,)

[151] Jansson, Johan, and Dominic Power. "The Image of the City: Urban Branding as Constructed Capabilities in Nordic City Regions," Noridc Innovation Center , October 2006

and thus induce competitiveness in a region. However, a large-size iconic building is costly. Besides unpredictable long-term commitments, a decision of creating a large-size iconic building may be a risk and lead to a negative urban brand. Therefore, reasonable and reliable cost-benefit estimates should be made seriously before the project is started.

A good example of large-sized iconic building/project that gained a controversial effect could be the Millennium Dome in London (Figure 4-20). The Dome is one of the best-known projects using architecture to celebrate an event in the history of a city and a nation. In this respect, the project has very much to do both with iconic buildings and an event as branding strategies[152]. The Dome is situated on the Greenwich Peninsula, in southeast London. Externally, it appears as a large white marquee with twelve 100-meter high yellow support towers, one for each month of the year, or each hour of the clock face, representing the role played by Greenwich Mean Time. In the plan view, it is circular and has a diameter of 365 meters. It has become one of the UK's most recognizable landmarks[153]. The structure solved with great elegance the issue of how to enclose and protect 100,000 square meters of enclosed space, as separate exhibition zones, from the vagaries of the British climate. The project has several functions:

First, it was built for an exhibition that should demonstrate technical and cultural achievements. Second, the building was an anchor through which new enterprises and developments could be attracted to the locality of Greenwich (the site of the Dome). Third, since the environment of the site was damaged, the project was also seen as instrumental for repairing the area with ecological and sustainability approaches[154].

Indeed, the Dome project really increased the pace in which the Greenwich area was developed. If the Dome had not been built, probably nothing would have happened on the site for a long time, as no development firm was willing to come close to it. However, except for the design quality, the project itself is still considered as a decision-making failure today. A long series of design faults, construction problems and skyrocketing costs reinforced the negative images the project generated. The public investment of $1,22 billion has still not been regained. "The dome became a symbol of how to get things wrong and a symbol for top-down planning that was out of touch with reality and the wants and

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[152] Jansson, Johan, and Dominic Power. "The Image of the City: Urban Branding as Constructed Capabilities in Nordic City Regions," Noridc Innovation Center , October 2006

[153] Wikipedia- the Free Encyclopedia, www.wikipedia.org

[154] Jansson, Johan, and Dominic Power. "The Image of the City: Urban Branding as Constructed Capabilities in Nordic City Regions," Noridc Innovation Center , October 2006

needs of the British public.[155]"

Even though grand projects such as the Eiffel tower and the Pompidou Center in Paris had the same problem with negative attitudes from the public at the beginning, these projects are now, of course, quite popular for both tourists and locals. However, large-sized iconic buildings may have inborn features such as a long plan-construction period, high investment volume, slow social effects/refunds and lack of flexibility. When the project involves public investments, then it has a high probability of being the target of public criticism. Before an airport starts operating, the local development model and the urban economic structure need a long time period to become fixed in the airport regions. Therefore, for making such projects in these areas, especially before airports start operating, it is very difficult to orientate the demands of urban developments in airport regions, and such projects are very likely to become a decision-making failure and provoke public criticism.

- **Smaller-Sized Building and Projects**

However, not all iconic buildings or projects are costly. A smaller-sized development project, when applied correctly, may have equivalent positive effects.

A good example to explain a smaller-sized iconic building, or a cluster of these that gained great reputation among its locals, could be the "Commune by the Great Wall" in Beijing. "Commune by the Great Wall" is a private collection of modern architecture and SOHO China-managed boutique hotel in Beijing, China. Zhang Xin, the mastermind and investor of the project, was recognized for her "bold personal initiative, which emphasizes the role of 12 Asian architects in building privately owned houses in a definitively contemporary manner".

The "Commune by the Great Wall" is near the Badaling section of the Great Wall. Badaling is one of Beijing's biggest tourist destinations. The Commune consists of private villas designed by 12 prominent Asian architects. The commune has a club house and 11 villas, each of which have a living room, dining room, kitchen, bedrooms and bathrooms, nestled in a valley totaling 8.0 km^2. This project's vision was to encourage creativity to influence a new generation of Asian architects, developers and consumers.

Because of its success foreseeability, outstanding architecture design and superior location,

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[155] Jansson, Johan, and Dominic Power. "The Image of the City: Urban Branding as Constructed Capabilities in Nordic City Regions," Noridc Innovation Center , October 2006

and also because it is a private project that cost no public funds, the commune has gained great positive response from the public. It has not only a high reputation in the architecture field, being considered as a milestone of Asian architecture, but also successfully attracted the media and public's attention, and soon became one of the most popular attractions for tourists worldwide. The Centre Pompidou now houses its exhibited model, as its first permanent collection from China. It was also exhibited at the Venice Biennial 2002 and won a special prize. In 2005, the Commune by the Great Wall was hailed by Business Week as a "New Architectural Wonder of China"[156].

Since the project opened to the public in 2002, the fame of the project is still increasing. The commune itself has also been gradually expanded for more profits, and the number of villas in the commune has been raised from 11 to 40. Now it is a destination for corporate functions, events, weddings, film shootings and fashion shows, and largely promotes the environment and popularity of the district where it is located.

■ **Regular Events for Urban Revitalization**

Regular events such as trade fairs, music or traditional festivals could also be considered as mental "landmarks" for their localities. They are indicators of a city's dynamism and business climate. In addition, events bring cities significant revenues in the form of business visitors and tourists. The effectiveness of trade fairs as a marketing and symbolic inducer, combined with the revenue they are brought by, has meant that there is intense international competition for events, and many cities are now investing large sums in both attracting trade fairs and festivals and in building facilities to support these events.

Trade fairs also have an essential role in supporting local firms' competitiveness. For companies, trade fairs are often the most direct and important route to new markets and distribution channels. Trade fairs have a general importance for the interchange of information and meeting industry participants as well as their export-promotion function[157]. Larger international trade fairs also attract significant media coverage that can be invaluable to firms trying to establish themselves in new markets.

For a community, the main point of attracting or advertising regular events should be based on one of three determinants. First, the regular events should take place in its locality and tradition. The Oktoberfest in Munich is a good example for advertising its traditional

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[156] Commune by Great Wall Official Website, accessed on December 2013 , www.commuebythegreatwall.com

[157] Jansson, Johan, and Dominic Power. "The Image of the City: Urban Branding as Constructed Capabilities in Nordic City Regions," Noridc Innovation Center , October 2006

events to promote the popularity and attract a large number of media and visitors for its host city. Second, the type of regular events / trade fairs should be based on local industries. The event may not only increase the added value by local "branding" of local industries, but these could also be enhanced and enlarged by advertising and trade possibilities provided by the event. A good example to explain the success of trade fairs that are based on local industries could be the Milan Fashion Week. Many famous fashion brands located in Milan make the event respectable and well-known, which has meanwhile largely improved the business environment for not only local fashion industry, but also tourism, hospitality, real estate and banking industries, and all industries that are concerned. Third, regular events should as well be based on a great booster for a community or a city that urgently needs to promote its urban image for revitalization. Berlin Music Week is a good example to explain a community that utilizes events based on a booster – the redevelopment of Tempelhofer Freiheit – as an inducer of urban revitalization.

Airport-surrounding communities, which have great accessibility to the airport and to the city, are regularly considered as the "the City's Gateway", and will gain great development opportunities brought by its nearby airport. Besides, airport-adjacent localities commonly have a large area of reserved land for further development. Therefore, airport regions have incomparable innate advantages in attracting regular events for its host city. Airport-neighboring localities, if intending to attract new or enhance existing regular events, may also seriously consider what and how to integrate the events into them.

When an airport-adjacent community aims to introduce a worldwide event, it must be by means of its host city's influence. Therefore, when considering what type of events should be selected as attractors, the scope of tradition and industries should be defined on city level, but not on community level. Furthermore, there is also a tendency in European cities to relocate their trade fair centers from the city center to airport regions because of easy accessibility. For example, Messe Stuttgart, which was the ninth biggest trade fair in Germany and has a 50-year history, has moved from Stuttgart city to its airport, and soon became a new landmark, attracting media coverage and public attention to the region. One of the most striking features of the Stuttgart Messe is its huge car park, which spans the A8 Autobahn. The car park has space for 4,200 vehicles on five stories. Display rights for the four-ton logo on both sides of the car park bridge were sold to Robert Bosch GmbH, which paid around 20 million Euro for exclusive advertising space. The logo is the second largest illuminated sign and the biggest logo in the world after the unlit Hollywood Sign.

Figure 4-19 The New Trade Fair Center of Stuttgart
Source: www. Wikipedia.org (public domain)

The airport region as a site for regular events has its unique attraction to some specific industries such as aviation, logistics and even high-tech-based and creative ones. Such areas are commonly clustered by firms based on logistics or aircraft manufacture, repair and research, which provides a good business environment for aviation trade; more importantly, it has the indispensable condition for airshow – the airport. Moreover, human capital industries such as knowledge and creative industries require world-class access for communications and frequent air travel for sales, training, expansion of knowledge via attendance at research symposia and conventions, for solving problems with customers scattered throughout the globe, etc. These factors require person-to-person communication more urgently, and air travel is an important element for fulfilling these requirements, while the airport-encircling region is the most efficient site for hosting trade fairs of such industries.

Architecture design and urban planning play an important role for localities to successfully host such large-scale temporary events. These places should represent the advantages of the city and the community thus should be developed with the highest architecture design and urban planning craft. Indeed, many places for large events have superb architecture. For example, the Milan authorities invited the most well-known international architects as a design team to work on the architecture design and urban planning of the site, in order to make a success of the Milan Fashion Week. These architects included Arata Isozaki, Daniel Liebeskind, Zaha Hadid and Pier Paolo Maggiora, which represents the world's leading contemporary architecture design quality.

4.3.4 Districts

■ **The Concept of "District" in Urban Image**

In "The Image of the City"[158], Kevin Lynch defined that "Districts are the medium-to-large sections of the city, conceived as having two-dimensional extent, which the observer mentally enters "inside of", and which are recognizable as having some common, identifying character. They can be recognized internally, and occasionally can be used as external reference as a person goes by or toward them". He also stated that "Usually, the typical features were imaged and recognized in a characteristic cluster, the thematic unit".

Unlike "landmark" and "nodes", which are individual elements, and "edge" and "path", which are like linear elements representing the image of the city, the concept of "district" concerns more an area composed by clusters of elements with certain characteristics, hence creating high legibility and easiness to be recognized. In architectural level, the characteristic elements could be building elements such as windows, doors, walls, fences, balconies; in the planning level, these could be buildings, urban textures and fabrics in the district.

■ **"Districts" of Airport-Surrounding Community**

A clear district image, in order to be distinguished from other urban regions, should be created based on specifics of its local environment and its intents regarding future development. For airport-adjacent communities, according to the previous SWOT analysis, the most prominent locality is such a community under the most direct impact from the airport, and its intents are to retain residents, and attract inhabitants, investments and companies related to the airport. Hence, creating a district image for airport-neighboring localities could be sub-divided to originate a livable residential area for local residents, as well as a good business environment in industrial and business zones.

The form and arrangement of dwelling follow specifics of local climate and environment, which could be traced back in a long history, and are a universal guideline for dwelling design. For example, the traditional stilt houses in southeast Asia are formed based on the local rainy and mega thermal climate. Pure white Mediterranean houses with thick walls are built intending to isolate high intensity of sunlight.

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[158] Kevin Lynch, *The Image of the City*, 1ST edition (Cambridge, Mass.: The MIT Press 1960).

The most evident influencing factor for creating a livable residential area in the airport region is aircraft and ground traffic noise. A “district” image based on noise protection is significant in decreasing local residents’ negative attitude towards the airport. Thus, a residential district image in an airport region that is distinguished from others should rely on the outwards image that reflects noise isolation concerns. There are several architectural design, construction and planning approaches for reducing noise impact on residents. Specific construction material and building elements such as acoustic balconies could be the matters of representativeness of the community’s character. This image of the district may not only physically protect local citizens from noise, but also emotionally provide a sense of security for local residents.

A good example of creating a clear image for multistory residential units could be the seashore residential area in the city of La Coruna in Spain. La Coruna is a port city located on a promontory, in the entrance of an estuary, in a large gulf of the Atlantic Ocean. It provides a distribution point for agricultural goods from the region. Because the climate of the city is rainy and stormy, there is a very clear architecture characteristic of its multistory residential units – the closed balconies as a “climate cover” to protect residents against storms. Although this image is not based on noise protection, indeed such architectural design approach could efficiently isolate not only the storm, but also noises from airports and other traffic sources, as well contribute to energy efficiency. Therefore, in airport-surrounding communities, such architectural approach could be a good reference in creating clear urban image based on noise isolation and energy saving for multistory residential units in airport regions.

Figure 4-20 Closed Balcony as a “Climate Cover” Creates a Clear Urban Image in the City of La Coruna, Spain
Source: www. Wikipedia.org (public domain)

There are also many references of low-density housing for airport regions based on specific building elements. For example, the “nature house” project designed by the Swedish architect Anders Solvarm, has integrated “Nutrient circulation, return clear water”, “Lowest environmental impacts” and “Energy Efficient” into his own rural house. It is not

only a great success in comfortable rural living, but also energy saving. In addition, this house has a very clear image in the rural residential region and also gains economic profits by attracting visitors and planting fruits and vegetables. Solvarm stated: “A climate envelope like a greenhouse can be a great possibility to develop and achieve comfortable living in houses with small footprints, also in cities”. These approaches could also be used in redevelopment of rural houses in airport-surrounding localities, with multiple benefits.

In fact, climate cover, as an energy-saving, noise-isolating and eco-friendly architecture design, adopts approaches that are now widely used in the architecture design field. Many examples demonstrate that buildings with climate cover have certain benefits, such as energy efficiency, eco-preservation and noise isolation, but also have their special architecture characteristic.

Figure 4-21 Rural House with Climate Cover
Source: Anders Solvarm

4.4 **Conclusive Summary**

In this chapter, the significant of creating a proper and strong urban image and urban branding in knowledge economic era has been well studied. Since economic growth and employment opportunities no longer rely on manufacture that is based on nature resources and materials, the knowledge economy is rather competitive between regions and cities as a consequence of intangible measures-the ability to attract and retain talented and creative labor, to provide interactive milieus where new ideas can grow. Many studies have also shown that in knowledge era, economy, firms, creative workers and entrepreneurs are drawn to places with strong and dynamic image and brands. Therefore, a strong and proper urban image is significant in promoting urban competitiveness in future urban development, especially in airport region.

An investigation of proper urban image and urban branding in airport region has been made. A SWOT analysis has been drawn to explain the proper airport image as:

1. It should maintain the reputation, the sense of belonging and the sense of security for both local residents and new inhabitants, for retaining the first and attracting the latter.
2. It should be efficient in creating an open business environment, providing sufficient service facilities, thus maintaining local companies and attracting new investments and firms.
3. It should be efficient in attracting visitors and tourists, creative industries and attentions from the media, hence promoting its attractiveness from outside observers.
4. Is should show the attitude that minimum airport negative impacts and maximum airport benefits, and in some points turn negative impacts into strengths.
5. A good and clear urban image for the whole airport region may promote competitiveness in a whole regional level, and communities' own images may induce competitiveness in relation to other neighboring localities.

Base on above principals, several urban development strategies that base on "path" as traffic corridor, "edge" as gray space between the traffic corridor and the urban space, "nodes" as communities themselves or railway stations, "landmarks" in large scale and small scale, "districts" as clusters of different land uses, which are five main elements of Kevin Lynch's urban image theory, have been drawn as approaches for creating a proper urban image. Several similar case studies that focus on using urban

development projects to promote urban image, and their development process and assessments have also been selected as references for creating airport regional urban images and urban brandings.

5 Implementation of Research Resultants in BER Airport Region

5.1 The Redevelopment of the BER Airport and its Associated Real Estates

■ Background of the BER Airport Expansion

Following the German reunification in 1990, Berlin once again became the capital of Germany. Berlin is also well connected to the rest of Germany, Europe and the world, offering 178 destinations in 49 countries in its 2012 flight schedule. In 2012, passenger figures for both commercial airports broke all previous records: for the first time, more than 25 million passengers were reported in a single year. With a year-on-year increase of 5.1%, air traffic in the Berlin-Brandenburg region thus outpaced the average international commercial airport in Germany (up approx. 1.1% on 2011) for the tenth consecutive year. This enabled Berlin-Brandenburg to consolidate its third-place position in the ranking of air traffic locations in Germany[159]. Plans were made to recognize the increasing importance of the city with the construction of a large commercial airport, as Tegel and Schoenefeld Airports are close to reaching their maximum capacities due to increasing passenger numbers and air freights. A single airport concept was pursued in order to ensure the economic viability of the project. This means that the new construction would become the sole commercial airport for Berlin and Brandenburg. As a consequence, it was decided to have Tegel, Schoenefeld and Tempelhof closed upon opening of the new airport.

■ Major Footprints of the BER Airport Development

On 28 May 1996, Eberhard Diepgen, Manfred Stolpe (then Governor of Brandenburg) and Matthias Wissmann (then Federal Minister of Transport) committed themselves to Schoenefeld as the site for the new airport. This so-called consensus decision was later confirmed by the respective state legislatures. The airport would even use certain infrastructure, like a runway, from the current Schoenefeld Airport. Henceforth, the airport

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[159] *Press Kit-Berlin Brandenburg Airport*. Berlin Germany: Flughafen Berlin Brandenburg GmbH, September 2014.

would be planned, owned and operated by the BBF Holding (which was renamed to Flughafen Berlin Brandenburg GmbH (FBB) shortly afterwards), which in turn is owned by Berlin and Brandenburg (37% each) as well as Germany (26%)[160].

On 13 August 2004, the planning approval for the development of the Schoenefeld Airport into Berlin Brandenburg International Airport (BER) was granted by the Brandenburg state ministry for infrastructure and regional policy[161].

To make way for the new airport, two villages had to be removed. This way, 335 inhabitants of Diepensee received compensation and were offered new homes in Koenigs-Wusterhausen, a move that was completed by late 2004. Further, 35 villagers of Selchow were resettled to Grossziethen in mid-2005[162].

On 5 September 2006, the groundbreaking ceremony was held. The construction of the new BER airport was then officially started. After nearly 15 years of planning, actual construction works for Berlin Brandenburg Airport began on this date.

Construction of the terminal building began in July 2008. On 8 and 9 May 2010, the topping out was celebrated with open days at the airport site[163]. Since 30 October 2011, the railway line and terminal station have been ready for service, though until opening no scheduled trains will operate at the airport.

On 24 November 2011, operating tests and service trials commenced (at that time, it was assumed that the BER would be opened on 3 June 2012). This phase also saw the acceptance tests of various airport systems.

On 8 May 2012, it became clear that the opening date would not be met due to failures in the fire protection system. All trials were halted and have not been resumed thus far[164]. As of February 2014, the BER Airport was still not opened, and the presumed opening date is unknown.

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[160] "Konsensbeschluss zur Tempelhof-Schließung," *Der Tagesspiegel Online*, June 18, 2007, accessed on July 2013 http://www.tagesspiegel.de/berlin/verkehr/dokumentation-konsensbeschluss-zur-tempelhof-schliessung/876062.html.

[161] *Planfeststellungsbeschluss-Ausbau Verkehrsflughafen Berlin-Schönefeld* (Ministerium für Stadtentwicklung, Whonen und Verkehr des Landes Brandenburg, August 2004).

[162] "Facts and Figures," *Berlin Brandenburg Airport*, accessed September 29, 2013, http://www.berlin-airport.de/en/company/about-us/facts-and-figures/index.php.

[163] *Press Kit-Berlin Brandenburg Airport*. Berlin Germany: Flughafen Berlin Brandenburg GmbH, September 2014.

[164] *Press Kit-Berlin Brandenburg Airport*. Berlin Germany: Flughafen Berlin Brandenburg GmbH, September 2014.

■ Master Plan BER Airport

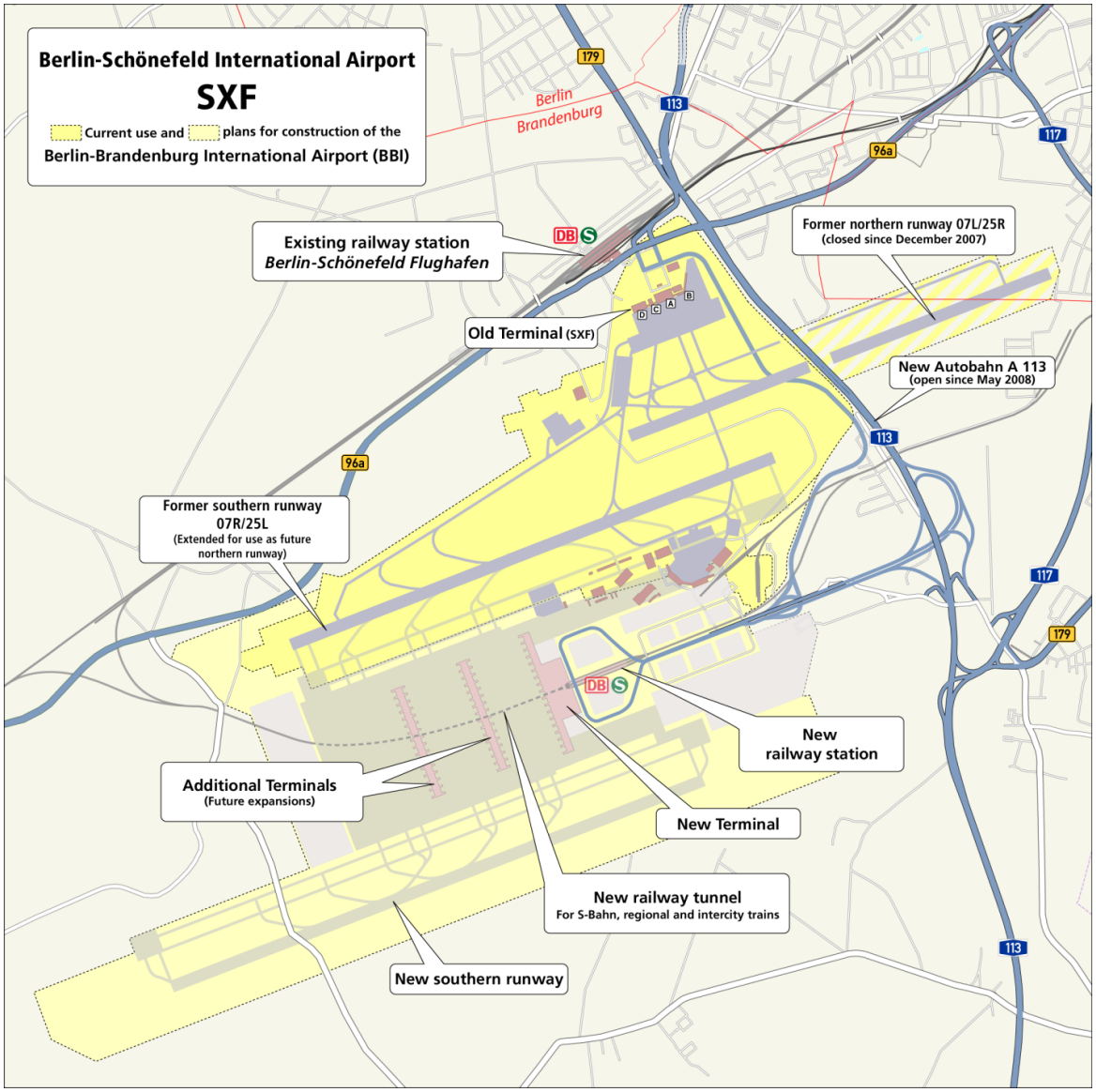

Figure 5-1 Map Berlin-Schoenefeld Airport SFX With Planed BBI
Source: www. berlin-airport.de

The new BER airport extends over 970 hectares of the existing Schoenefeld Airport. The airport will cover a total area of 1,470 hectares, the size of around 2,000 football fields. The U-shaped terminal building of Berlin Brandenburg Airport has been designed by the architectural company gmp, which had already been responsible for the hexagonal terminal A of Tegel Airport, opened in 1974. At BER, the terminal is situated between the two runways, creating a so-called midfield airport on top of the underground 6-lane train station. There are four publicly accessible stories. The new terminal is equipped with 25 jet bridges, plus another 85 aircraft stands on the apron. The boarding and arrival areas are

divided into three piers. Eight of the gates can accommodate wide-body aircrafts. One gate has been designed to accommodate the Airbus A380, the current largest commercial airliner[165].

The northern runway of BER is the southern runway of the old Schoenefeld Airport, and has been in use since the 1960s. To cater for the new airport, it has been renovated and lengthened from 3,000 to 3,600 meters[166].

- **Capacity of the BER Airport**

The Berlin Brandenburg Airport will have a starting capacity of 27 million passengers once it goes into operation. Depending on passenger development, the airport can be expanded to accommodate up to a maximum of 45 million passengers.

The first development stage entailed Dietz AG building, a cargo center with direct apron access for handling belly freight on an area of approximately 3.3 hectares. This includes a total of 12,000 m^2 of hall space and an additional 7,000 m^2 of office space. The cargo center will initially be able to handle approx. 100,000 tons of cargo per year. The cargo hall will have a refrigeration center for handling 70 to 120 EURO pallets of perishable goods. It will be possible to expand the air cargo terminal gradually to meet the demand[167].

- **Associated Real Estate Development of BER Airport**

Due to the air transport impact on business operations, nowadays air transport enables companies to service and meet clients and promote the efficient organization of productions. When it comes to traffic hubs, major airports are high-frequency to promote communication and increase the visibility of the companies located within them. Thus, the airport field has innate advantages that attract business clusters, and the revenues of the real estate sector now correspond to an increasingly larger proportion of total airport benefits. Let us take the Amsterdam Schiphol Airport as an example. Although the economic crisis has evidently hindered the real estate sector in the Netherlands and the demand for office space continues to drop, according to statistics of 2012 the occupancy of the total area of 565,000 m^2 of the Schiphol Airport real estate sector (including offices, commercial space, operating properties) has still steadily increased, from 88.5% in 2011 to 91.8% in 2012. The total revenue of the real estate sector of Schiphol Airport is as high as

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[165] *Press Kit-Berlin Brandenburg Airport*. Berlin Germany: Flughafen Berlin Brandenburg GmbH, September 2014.

[166] *Press Kit-Berlin Brandenburg Airport*. Berlin Germany: Flughafen Berlin Brandenburg GmbH, September 2014.

[167] *Press Kit-Berlin Brandenburg Airport*. Berlin Germany: Flughafen Berlin Brandenburg GmbH, September 2014.

11% of the airport's total revenues[168].

The BER's broad portfolio currently comprises a total of eight development areas, which are located both within the airport grounds and outside the security fences. Such plots are suitable for diverse airport-related industries such as office, hotel, leisure, meetings and conference, trade, and logistics and light manufacturing as well as airport-specific services. The real estate developments of the BER airport mainly include eight plots (Figure 6-2).

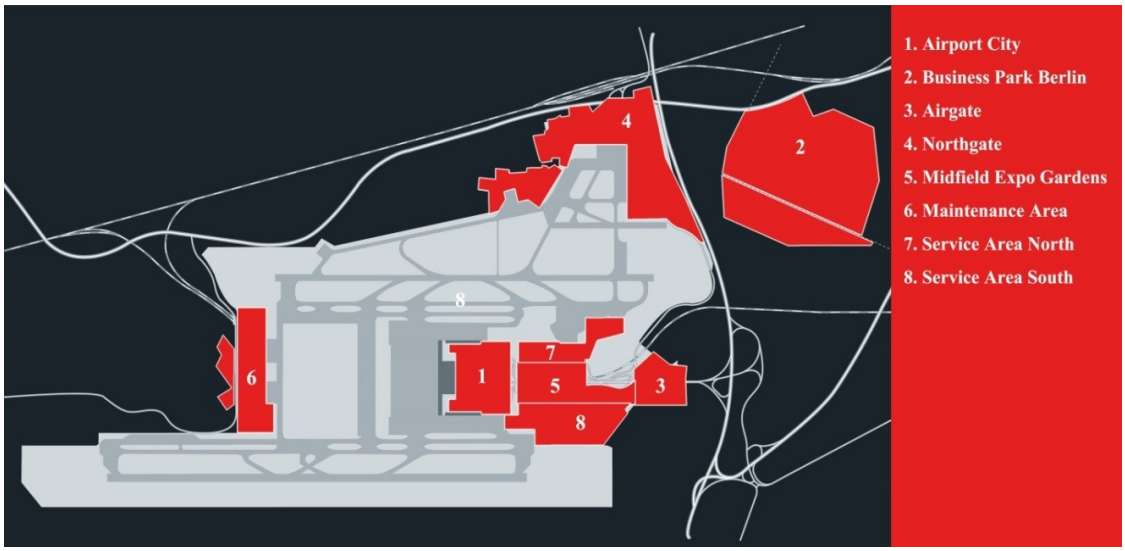

Figure 5-2 Real Estate Sites of the Berlin Brandenburg Airport
Source: Revised by the author according to "Real Estate Sites and Visions" from www.berlin-airport.de

■ Scope of BER Airport Region

The scope of the research – the airport-surrounding localities – are defined as 12 communities that host or are located near the new BER airport, and which receive the most direct influence from the airport. These communities are located in two counties of Brandenburg, the counties of Teltow-Flaeming and Dahme-Spreewald. These localities are Blankenfelde-Mahlow, Eichwalde, Gosen-Neu Zittau, Grossbeeren, Koenigs-Wusterhausen, Ludwigsfelde, Mittenwalde, Rangsdorf, Schoenefelde, Schulzendorf, Wildau and Zeuthen.

[168] *Fact & Figure 2012* (Schiphol Group, 2013), access on April 2014 file:///C:/Users/yang/Downloads/88541_Feiten+Cijfers_2012_EN.pdf.

Figure 5-3 Scope of the Berlin Brandenburg Airport-Surrounding Urban Region
Source: By the author

5.2 Prediction of BER Airport Impact on Demographics

5.2.1 Evaluation of Demographic Status in BER Airport Region

As mentioned at the beginning of Chapter 3, social structures such as population density, proportion of elderly people and unemployment ratio are determinants in understanding the status, and constitute a significant planning basis. The population density outlines the urbanism level and attractiveness of each locality; population density and unemployment ratio together outline the availability of labor resources, and thus the attractiveness for locating new industries and firms; and the age structure of each community outlines the urban vitality.

In Europe, the higher unemployment rates often appear at more urbanized regions. A better economic situation, more job opportunities and advanced service facilities attract young families from suburban regions into more urbanized ones. An equation could be deduced that a higher population density equals a higher unemployment rate and a lower proportion of elderly people. For example, in all case study airports, the cities' unemployment ratios are higher and the proportion of elderly people is lower than in their suburban rings. More urbanized communities in these rings also have a higher population density, a higher unemployment ratio and lower proportion of elderly people.

Currently, in Schoenefeld airport-neighboring localities, the population density is three times higher and the proportion of elderly people is obviously lower than the average level

of the state of Brandenburg, which indicates that the BER airport-surrounding communities are more urbanized than the mean level of the Brandenburg state. However, the unemployment rate in such communities is uncommonly lower than the average of Brandenburg. This means that such communities not only have better job opportunities and more advanced service facilities that attract young families, but have also performed even better on decreasing unemployment rates under the stress of a highly dense population, which represents a more stable and healthier business situation. Once the BER airport starts operating, the impacts will continuously increase under its influence.

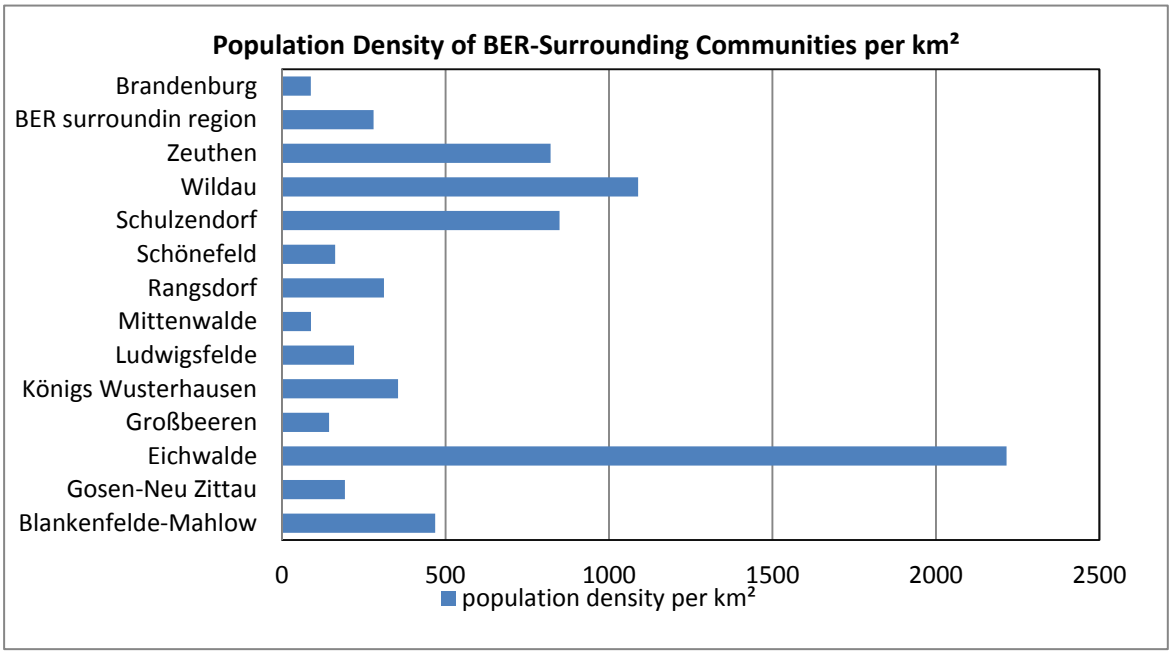

Figure 5-4 Population Density of BER Airport-Surrounding Communities 2010 (people/km^2) in 2010
Source: By the author according to data from the Berlin-Brandenburg Statistics Bureau

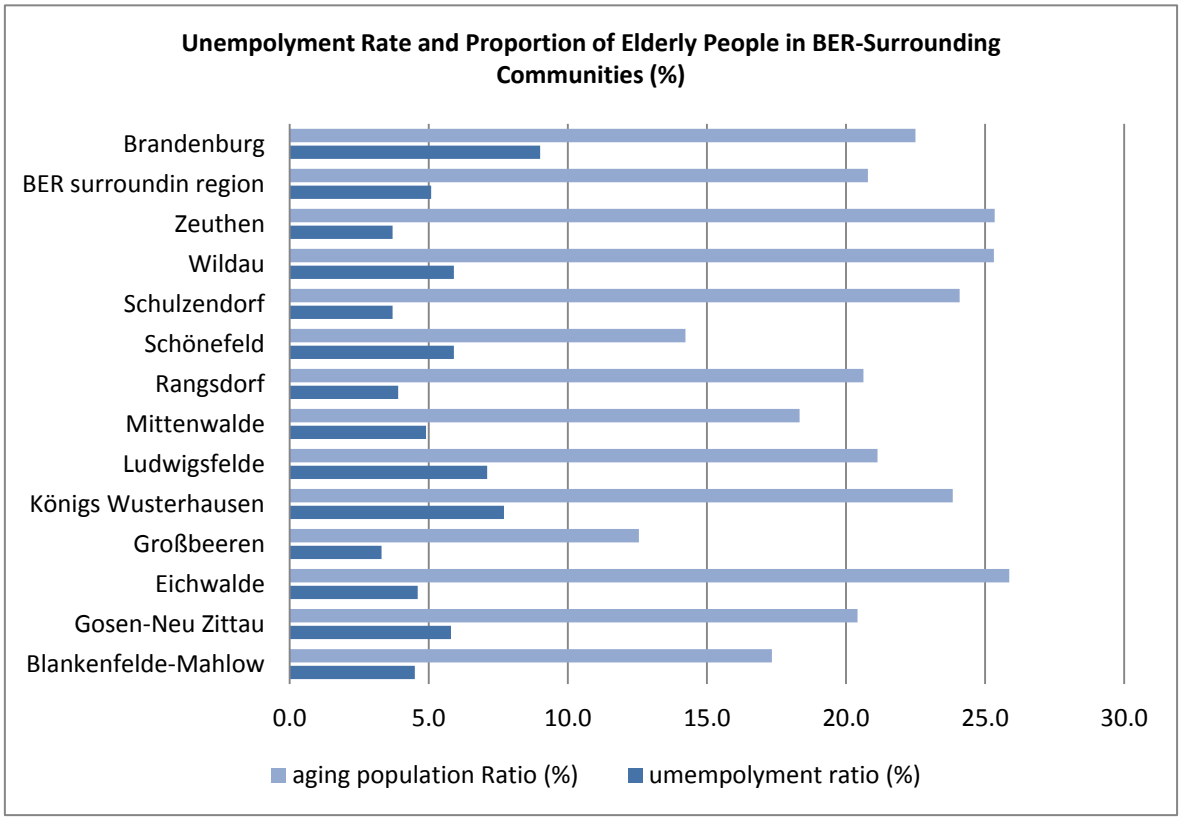

Figure 5-5 Unempolyment Ratio and Aging Population Ratio of BER-Surrounding Communities (%)
Source: By the author according to data from Berlin-Brandenburg Statistic Bureau

In a microscopic view, we could also conclude several features from the above figures:

1. The community of Schoenefeld, which is the host community of the current Schoenefeld airport, has an extremely low population density and a lower proportion of elderly people. The unemployment rate in Schoenefeld is also higher than in other BER-encircling communities. This indicates that the current Schoenefeld airport already has characteristic airport impacts on its hosting community by decreasing the population and proportion of elderly people, and to a certain extent increasing the unemployment rate. Thus, the community of Schoenefeld already shows the social constitutional features of a typical aero-related community.
2. The communities of Eichwalde, Schulzendorf, Zeuthen and Wildau are situated on the east side of the BER airport and next to southeast Berlin. These four communities constitute highly dense settlements, with the highest population density among the BER-surrounding communities. Moreover, the proportion of elderly people in these four communities is also the highest in the BER region.
3. Unlike communities located in the noise contour of other case study airports, the community of Blankenfelde-Mahlow, which is situated next to the current Schoenefeld airport and in the direction of the flight routes, shows even higher population density than the average level of BER-surrounding localities. The proportion of elderly people

is also lower than average. Therefore, even Blankenfelde-Mahlow is under the most serious noise impact from the BER, though its social structure is still in a good shape for future developments. On the other hand, after the BER airport starts operating, the community will demand more noise-protecting funds and solutions than in other case study airports.

5.2.2 Prediction of BER Airport Impact on Population Density

Based on the results of the evaluation of other case study airports, when the BER airport starts its operations, the drastically increasing airport passenger volume, as well as a large number of employees in airport direct, related and induced industries will have certain influence on the social structure, such as population density, unemployment rate and proportion of elderly people in the BER airport region. These social constitutional variations are significant preconditions for decision making regarding urbanization and revitalization of communities near the BER airport.

According to evaluation of the Flughafen Berlin Brandenburg GmbH, when the BER becomes the sole airport serving the Berlin-Brandenburg metropolitan region, the passenger flow will grow from 6.7 million to approximately 27 million[169]. Based on statistics of air passengers in airports of Berlin from the year 2002 to 2013, their number is steadily growing by about 7.33% per annum. Berlin is the only location in Europe capable of almost doubling its air traffic capacity to up to 45 million passengers, this way securing its growth and competitiveness for years to come[170]. Based on economic predictions, the steady economic growth will last for years in the Berlin-Brandenburg region, and the airport passengers will steadily increase. According to the prognosis of Figure 5-6, with the mean increase rate of 7.3% in the annual passenger flows of Berlin airports, if the BER airport started operating in 2014, its passenger volume would reach 28.5 million. The prognosis also shows that, at the end of 2018, if the passenger flow still increases by this rate, the number will be increased to as much as 37 million.

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[169] "Traffic Statistics," *Berlin Brandenburg Airport*, accessed August 07, 2014 , http://www.berlin-airport.de/en/press/background-information/traffic-statistics/index.php.

[170] *Press Kit-Berlin Brandenburg Airport*. Berlin Germany: Flughafen Berlin Brandenburg GmbH, September 2014.

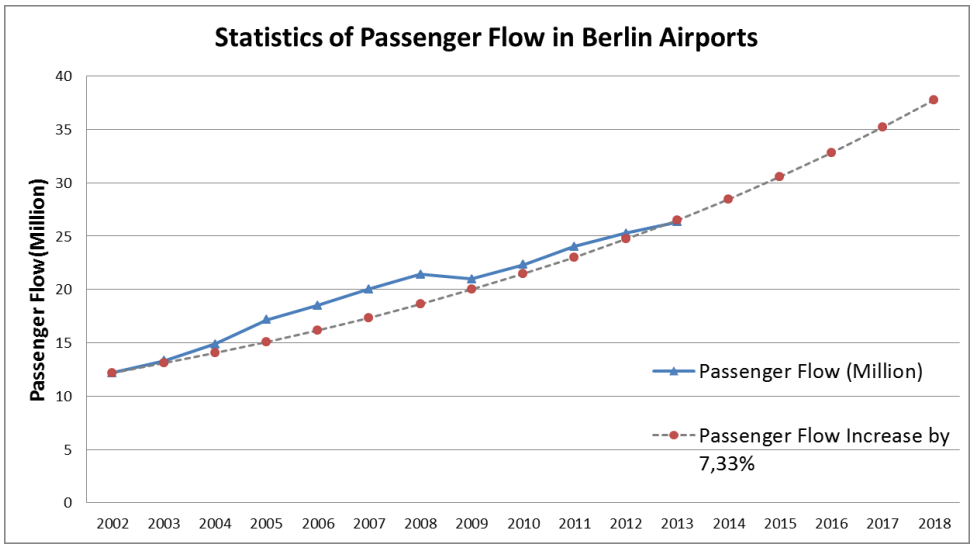

Figure 5-6 Statistics and Prognoses of Annual Passenger Number in Berlin

Source: By the author

When the BER Airport goes into operation, due to the drastic increase in airport passengers, the new BER airport will also be seen as a job motor for the whole region. In 2006, there were only 5,713 direct jobs provided by the Schoenefeld Airport, serving 5,597,627 passengers. After the opening of the BER Airport, according to the BER operators, "with 20,000 employees, Berlin Brandenburg Airport will be the biggest workplace in East Germany"[171]. The direct workplaces provided by the BER Airport are nearly three times more than the number of employees in the current Schoenefeld Airport. According to the statistics of the ACI Europe, 20,000 direct jobs will create 42,000 indirect/induced jobs nationally, 21,000 jobs regionally, and 10,000 jobs sub-regionally[172]. Due to the rising number of annual air passengers in later years, airport direct, indirect and induced jobs will continuously increase. Moreover, due to convenient access to the BER Airport, even if it is not in operation yet, the airport region is already attracting numerous airport-related companies or headquarters and institutions into clustering. According to other case study airports, more than half of employees in the BER Airport or in airport-related industries will settle in the airport region. Therefore, a large number of inhabitants will be situated in the BER airport region, thus changing the social structure, such as population density, unemployment rate and proportion of elderly people in the region.

To predict BER Airport impacts on its region, the first step is to define the scope of the airport region and the suburban ring. The airport region is considered as 12 towns

[171] "Airport Job Market Gains Momentum:," *Berlin Brandenburg Airport*, accessed September 29, 2014, http://www.berlin-airport.de/en/press/press-releases/2012/2012-03-21-airport-jobmarket/index.php.

[172] The Social and Economic Impact of Airports in Europe. Airport Council International (ACI), January 2004.

(Gemeinden), has an area of 574.8 km^2, a total population of 160,813 and a population density of 279 people/ km^2. The proportion of elderly people in the airport region is of about 33,425 people, corresponding to about 20.7%. Excluding the cities of Berlin and Potsdam, the Berlin-Brandenburg metropolitan region includes 67 towns (Gemeinden) and a total area of 4,389 km^2 and a population of 904,135, with a population density of 206 people per km^2. The proportion of elderly people in this region is 179,941 and the proportion of elderly people is about 20%.

According to the linear regression study in Chapter 2, the annual passenger number of an airport has a correlation with the difference of the average population of the airport region and the suburban region. The formula that supports the prediction is:

$$y_{a/s=}\ 4{,}11E\text{-}08x_a + 0.287$$

x_a stands for the annual air passenger volume of BER Airport and $y_{a/s}$ is the quotient of airport region's population density divided by suburbs' population density. If x_a is known as 27 million passengers per annum, $y_{a/s}$ is the quotient of airport region's population density divided by suburbs' population density, and could be calculated as 1,397. If the suburban region's population density is 206 people/ km^2, then it could be estimated that the average population density of 12 towns in the airport region will grow from 279 people/ km^2 to 287 people/ km^2. If the amount of BER airport passengers grows from the starting 27 million to 30 million, the population density of the BER Airport region will grow to 313 people/ km^2. If the number of BER airport passenger grows to 35 million, the population density of the BER Airport region will grow to 355 people/ km^2. If the amount of BER airport passengers grows to 40 million, the population density of the BER Airport region will grow to 397 people/ km^2. If the number of BER airport passengers rises to 45 million, which is the maximal capacity, the population density of the BER Airport region will grow to 440 people/ km^2. Thus, the BER Airport will bring a significant number of new inhabitants to relocate into the airport region, and will provide opportunities for old industrial communities to revitalize and lead non-urbanized communities to go a step further in this aspect.

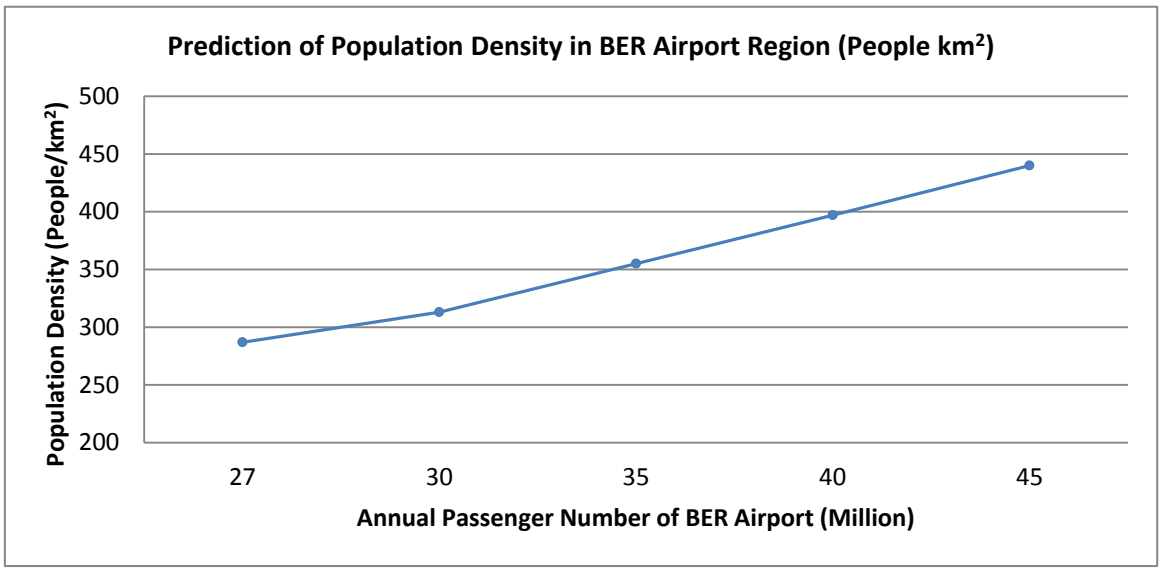

Figure 5-7 Prediction of Population Density in the BER Airport Region based on Annual Passenger Number of BER Airport
Source: By the author

However, there are several population density features that one could conclude from the BER Airport region.

First, the distribution of population drastically varies in the BER airport regions. For example, the population density of the community with maximum value (Eichwalde, 2,216/km^2) is nearly 25 times higher than the community with minimum population density (Mittenwalde, 88/km^2). From the background one can see great differences in the urbanization level between communities of BER Airport regions. Therefore, the incoming BER Airport should give opportunities for such communities to coordinate the urbanization levels, and for non-urbanized communities to promote their urbanization.

Second, one can also recognize the imbalance of industrial structure and population density in communities of the BER Airport region. For example, Eichwalde as the community with the highest population density is currently only recognized as a residential community, with nearly no polar industry. Although the community has sufficient labor force, such force consists of commuters that live in Eichwalde and need to travel to the workplace or move via airport ground transport system at least once a day. Let us take Ludwigsfelde and Grossbeeren as another example. These two communities currently are the most prominent industrial and business hot spots. However, they now have nearly the lowest population density in the whole BER Airport region. When more and more urban developments are established, especially business parks surrounding the BER Airport, a large number of commuters from/to these communities, especially Eichwalde, will increase the burden of the ground traffic system with both passengers and airport employees. This may cause

traffic congestion during the rush hour, which is a significant problem to the reputation of an airport. Therefore, the incoming BER Airport may provide an opportunity for such communities to balance the economic structure by planning new residential units in high-density business parks, in high population density communities, this way releasing the traffic pressure and balancing the land use structure for communities in the BER airport region.

Third, the imbalanced distribution of population also appears geographically. Although ground accesses to airports and to Berlin city in communities on the west side of BER Airport have the same capacity as communities on the east side, on average the population density of those on the east side is much higher than on the west. Prominent population clusters are found along the belt composed by Eichwalde, Schulzendorf, Zeuthen, Wildau and Koenigs-Wusterhausen, to the east of BER Airport. There are no obvious population clusters at communities on the west side of the BER Airport, except Blankenfelde-Mahlow, which is next to the BER Airport and suffering the most direct airport noise impact from the it. Therefore, for making further development plans, the geographical imbalance of population distribution should be seriously considered, and more residential development projects should be planned on the west side of the BER Airport region.

5.2.3 Prediction of BER Airport Impact on Proportion of Elderly People

The proportion of elderly people is another significant determinant for evaluating the vitality of the social structure in an urban region. A high proportion of elderly people in the social structure lead to social and economic problems, and loss of competitiveness in attracting investments and working-age people, thus losing activities for urban development. The proportion of elderly people is also an important precondition that impacts the land-use planning as well as spatial structural planning of the urban region.

According to the linear regression study in Chapter 3, an airport has an obvious effect in decreasing proportion of elderly people. To estimate the passenger traffic impact of the Berlin Brandenburg Airport on the variation of population density in its periphery, the following model, which was concluded to be significant in the previous study, was employed:

$$y_a = 0{,}68\, x_s - 7{,}45E\text{-}08\, x_a + 6{,}228$$

In the above model, the dependent variable y_a is the proportion of elderly people of the airport region, the explanatory variable x_s is the proportion of elderly people of Berlin suburbs, and the explanatory variable x_a is the starting passenger traffic of Berlin Brandenburg Airport. Therefore, by substituting the known percentage of population aging in Berlin suburbs (20.4%) and the starting passenger traffic of Berlin Brandenburg Airport (27 million) in the above model, then the unknown percentage of aging population in the airport region is found to be 18.05%. This indicates that, after the airport starts operating, the proportion of elderly people in the airport region will decrease from 20.9% to 18.05%. If the annual passenger number of the BER airport reaches 30 million, the proportion of elderly people in its surrounding region will decrease to 17.87%. If the annual passenger number of the BER airport reaches 35 million, the proportion of elderly people in the

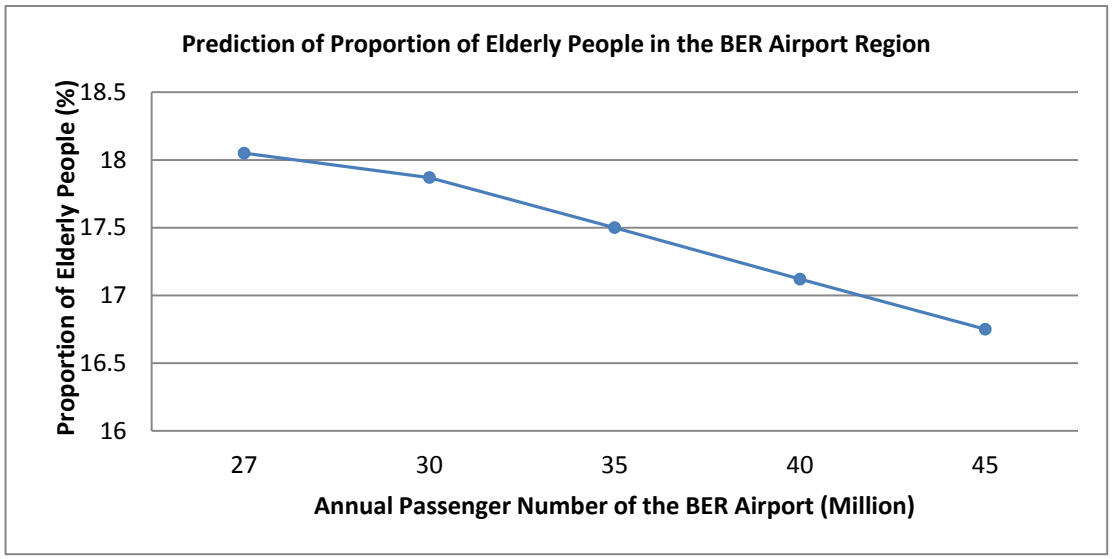

Figure 5-8 Prediction of Proportion of Elderly People in the BER Airport Region based on Annual Passenger Number of BER Airport

Source: By the author

region will decrease to 17.5%. If the annual passenger number of the BER airport reaches 40 million, the proportion of elderly people in its region will decrease to 17.12%. Finally, if the annual passenger number of the BER airport reaches 45 million, its maximum capacity, the proportion of elderly people in the airport region will decrease to 16.75%.

5.3 Evaluation of BER Airport Impact on Land Use

5.3.1 Evaluation of Land Use Distribution Status in BER Airport Region

■ Economic Status of BER-Surrounding Communities

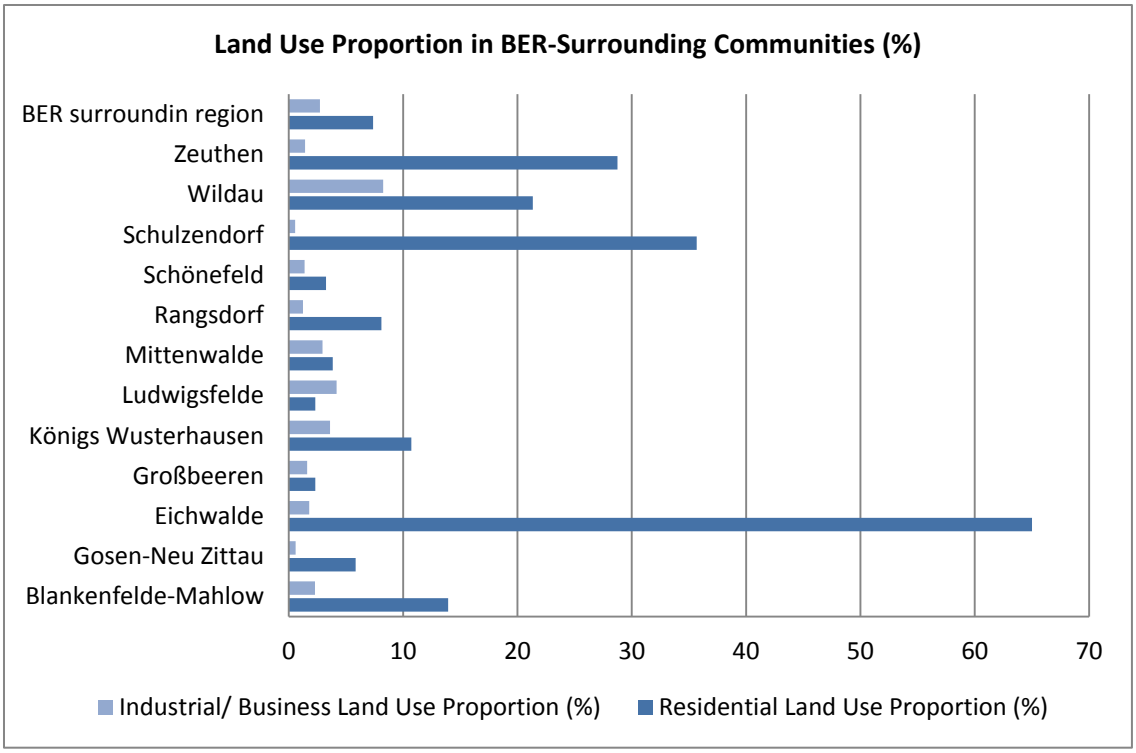

Figure 5-9 Industrial/Business and Residential Land Use Proportion in BER-Surrounding Communities

Source: By the author according to appraisals for real estate values of the district Dahme-Spreewald

Community	Industrial/Business	Residential	Note
Blankenfelde-Mahlow	C	D	A: Very little remaining space available. New constructions must base on densification of occupied spaces and existing buildings. B: Small plots (<10 ha) of existing and developed land available C: Certain amount of reserved land available (available area between 10 and 50 ha) D: At least 50 ha reserved land for development. Especially larger plots with several contiguous acres
Eichwalde	A	C	
Gosen-Neu Zittau	A	A	
Grossbeeren	C	C	
Koenigs-Wusterhausen	D	D	
Ludwigsfelde	D	D	
Mittenwalde	C	C	
Rangsdorf	B	B	
Schoenefeld	C	C	
Schulzendorf	A	A	
Wildau	C	B	
Zeuthen	B	B	

Table 5-1 Categories of Free Land for Further Development in BER Airport-Surrounidng Communities

Source: By the author according to data from"RG FU BER", Gesellschaft für Innovationsforschung und Beratung mbH, 2012

The existing economic status of the BER-surrounding communities could be considered as the research basis in evaluating their future development opportunities. The proportion of industrial/business land use outlines the business activity of an urban region; the statistics on the amount of yearly overnight tourists show the current attractiveness of communities. The proportion of residential land use reflects the community's capacity of acceptance towards new inhabitants. The value of available reserved land also shows the development potential in each of the BER-neighboring communities.

Three points could be concluded from the above figures:

1. The communities of Eichwalde, Zeuthen and Schulzendorf together form a region with highest proportion of residential land use and extremely low industrial land use. The proportion of residential land use in the community of Eichwalde is as high as 65%, when including land occupied by necessary service facilities and infrastructure; the community has rare reserve land for further progress. The main urban function of these communities is one-sided towards residential ends, with neither available reserve land nor polar industry for business development.
2. Ludwigsfelde is one and the only community in which industrial and business land use is larger than the residential land use. Thus, the community mainly focuses on industrial and business development, and a large-sized industrial region is already

formed. Moreover, Ludwigsfelde has a large reserve land area for both residential and industrial progress. Therefore, this community has great opportunity and potential for further advancement, and may become the most significant urban development core in the whole region.

3. The community of Wildau is located at the southwest of the Schoenefeld airport, and was known for its manufactures in the 20th century. The Berliner Maschinenbau AG (BMAG) established a large area of industrial land for its locomotive manufacture works in 1900. During the World Wars I and II, the production was partially converted into armaments such as aircraft components, from 1907 by Maffei Schwarzkopff and from 1936 by AEG. After 1949, the industrial workshop was united into one state-owned enterprise, and the production was switched from locomotives to heavy machinery (Heinrich Rau). After 1990, the enterprise was shut down by the Trust Agency.

   On the one hand, Wildau has a superior heavy industrial foundation. One the other hand, it is now also facing the challenge of industrial transformation. Nowadays, there are several successful heavy machinery firms as well as a university being erected in the old industrial area, which is a good sign of industrial transformation. However, problems such as higher proportion of elderly people and higher unemployment ratio still need to be solved.

4. The communities of Blankenfelde-Mahlow, Koenigs-Wusterhausen, as well as Grossbeeren and Mittenwalde have a certain industrial foundation. Moreover, such communities have large areas of reserved land for both residential and industrial development. Therefore, they are most flexible to develop under the impact of the new BER airport.

■ **Ground Traffic Network at BER**

Berlin, the capital of Germany, and the state of Brandenburg lie in the geographical center of Europe. The superior location provides significant status for the whole Berlin-Brandenburg region as an important transportation node linking West and East Europe. Indeed, the Berlin-Brandenburg metropolitan region has at present developed as a dynamic urban area with special opportunities for economy, scientific research, culture and tourism. The capital region is now a European transportation hub with six autobahns, ten arterial railway lines, two high-speed railway lines and three waterways[173].Thanks to an advanced ground

[173] Berlin Logistics and Transport, The Berlin Science Portal, Accessed 15 January 2014 , http://www.berlin-sciences.com

transportation network, from Berlin passengers could reach Paris in eight hours and Amsterdam in seven hours by high-speed train.

There is already a good traffic network serving the Schoenefeld airport (Figure 5-7). The airport region now has a supreme motorway network for drivers. The airport is directly connected to the motorway A113, an international road that passes through the communities of Mittenwalde and Schoenefeld and reaches Dresden and Poland to the south, and Berlin downtown to the north. The A113 offers a fast and direct connection to downtown Berlin and the Berliner Ring motorway A10. The A10, which crosses the communities of Koenigs-Wusterhausen, Mittenwalde, Rangsdorf, Blankenfelde-Mahlow and Ludwigsfelde, provides multi-directional connections to the European motorway network. Via A10, drivers could reach Leipzig via A9; Ruhr and Paris via A2; the Baltic Sea via A24, B96 and A11; and Poland and Czech Republic via A13 and A12. The four-lane roadways B96 and B101, which pass through the localities of Blankenfelde-Mahlow, Rangsdorf, Ludwigsfelde and Grossbeeren, run in parallel to the motorway A113 and provide the airport with a second route to the city and the European motorway network.

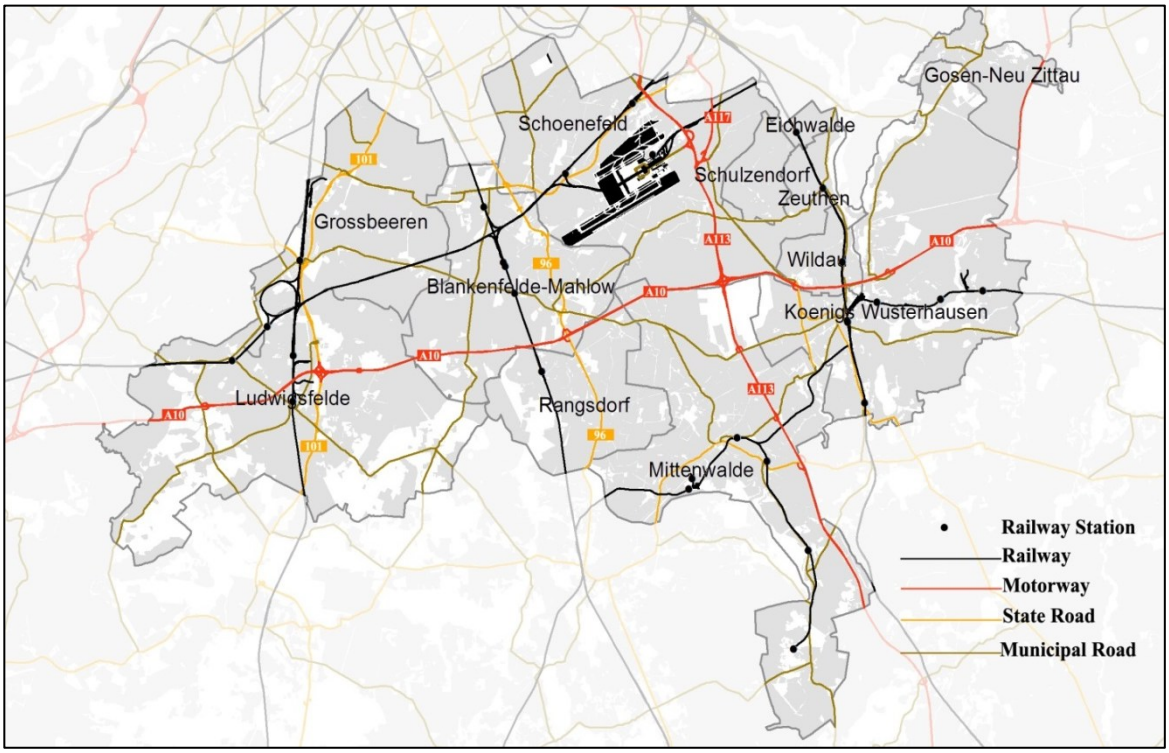

Figure 5-10 Ground Traffic Network at the BER Airport Region
Source: By the author

The BER airport region also has an advanced railway/light rail network system. The airport express connects the Schoenefeld airport with downtown Berlin. In the future, trains will run

every 15 minutes between Berlin Central Station and the BER, and the journey will take about half an hour. Numerous S-Bahn (light rail) lines also provide connections from the BER airport to Berlin downtown, across the BER airport region.

There are also advanced regional, long-haul and freight railway connections passing through the BER airport region. There are three railway lanes parallel to the motorway A113: the Goerlitzer Bahn via BER interchange terminal, passing through Mittenwalde, Koenigs-Wusterhausen, Wildau, Zeuthen, Schulzendorf and Eichwalde; the Dresdner Bahn, crossing the localities of Blankenfelde-Mahlow and Rangsdorf; and the Anhalter Bahn (Leipzig), passing across Ludwigsfelde and Grossbeeren. There is also a railway intersection with other three railways, which crosses the communities of Schoenefeld, Grossbeeren and Ludwigsfelde to the city of Potsdam.

According to Güller and Güller, the bigger the airport, the bigger the area/urban territory affected by it[174]. Being the main gate of a region into the world, it is necessary not only to link the airport to the main city itself, but also integrate it into the various regional and national traffic networks. There is, above all, an urge to improve access to public transportation networks, since airports are increasingly enmeshed in larger urban region[175]. Coincidentally, the location of the BER airport is indeed the most suitable place, with the densest and most convenient ground transportation networks in the whole Berlin suburban ring. Thus, these advanced ground traffic networks will provide a good foundation for the BER airport region's economical and urban development.

5.3.2 Density Analysis of the BER Airport Region

The Kernel Density tool calculates the density of features in a neighborhood encircling those features. Larger values of the search radius parameter produce a smoother, more generalized density raster. Smaller values produce a raster that shows more detail. Only the points or portions of a line that fall within the neighborhood are considered when calculating density. If the scale factor units of an area are small relative to the features (distance between points or length of line sections, depending on feature types), the output values may be small. To obtain higher values, the area scale factor for larger units should be selected (for example,

[174] Guller, Mathis, and Michael Guller. *From Airport to Airport City*. Barcelona: Gustavo Gili, 2003.

[175] Guller, Mathis, and Michael Guller. *From Airport to Airport City*. Barcelona: Gustavo Gili, 2003.

square kilometers instead of square meters)[176].

A GIS density analysis was performed for better understanding the status of the spatial structure and land use distribution in the BER airport. The information of each land use distribution, such as residential, commercial, industrial, leisure and recreational, research and educational uses, was extracted from the land use map, and the area of each piece of land use was calculated. Such analysis not only shows the current land use distribution in a more abstract way, which makes it easier and clearer for people to understand the land use distribution status than reading a land use map, but also reveals the spatial cluster core and cluster tendency of the BER airport region (see Figure 5-11).

[176] Kernel Density, accessed on 20.01.2014, www.arcgis.com

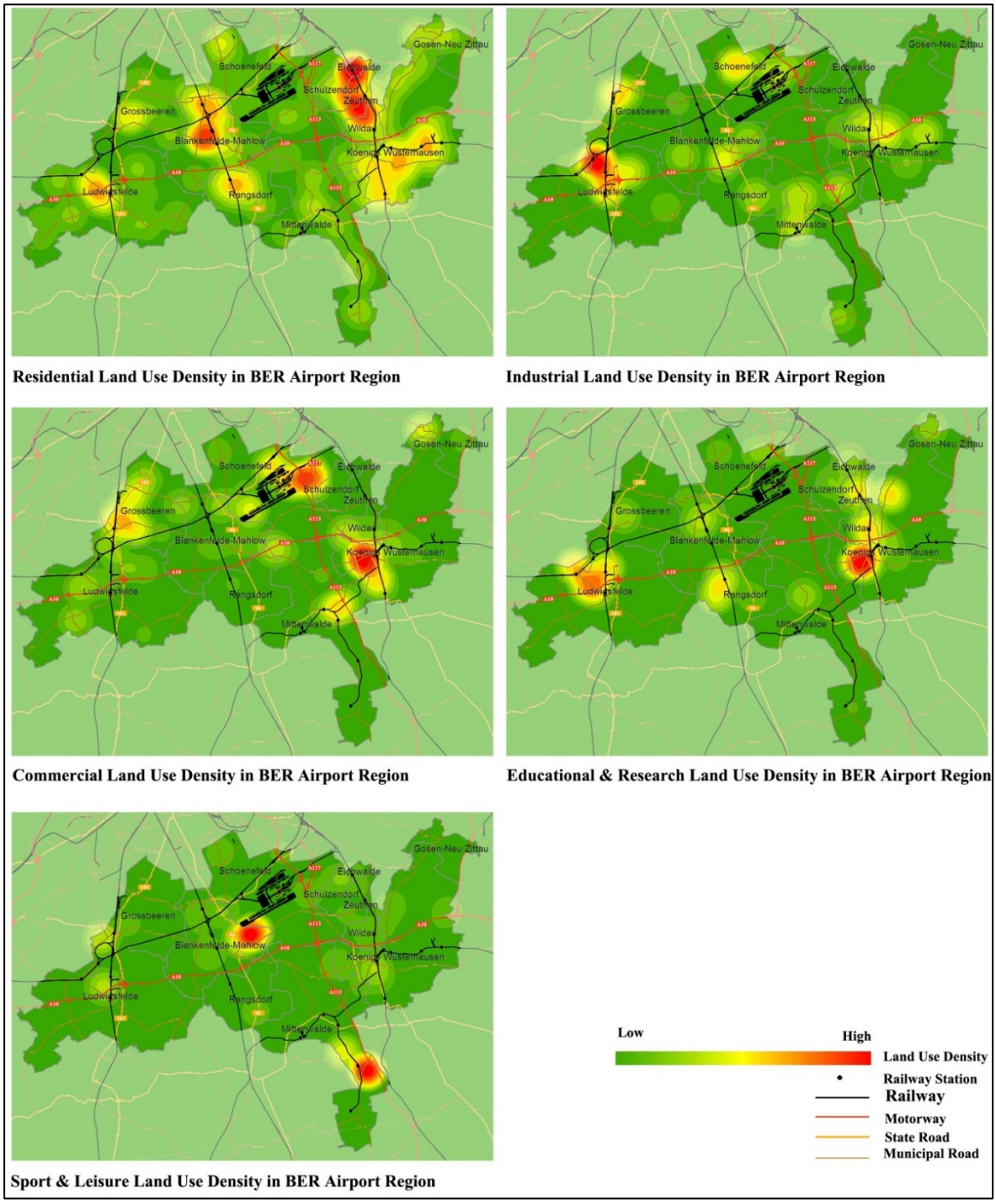

Figure 5-11 Land Use Distribution of the BER Airport Region
Source: By the author

The land use distribution and cluster features could be clearly seen from the resultant of the BER airport region. The most obvious residential land use clusters appear in the communities of Eichwalde, Schulzendorf, Wildau and Zeuthen, which are located to the east of the Schoenefeld airport and along the Goerlitzer railway. The community of Koenigs-Wusterhausen, which is located at the southeast of the Schoenefeld airport and along the Goerlitzer railway, and the localities of Blankenfelde-Mahlow and Rangsdorf,

which lie at the west border of the Schoenefeld airport and along the Dresden railway, appears as the secondary residential clusters in the BER region.

As regards commercial and industrial land use clusters, the most prominent industrial cluster appears in the community of Ludwigsfelde, which is located 15 km to the west of the airport and at the crossing of the Anhalter and the Potsdamer Railway, and also along the Highway A10. The evident industrial clusters could also be found in the community of Schoenefeld, which is the host community of the Schoenefeld airport, and the communities of Grossbeeren, Wildau and Blankenfelde-Mahlow. The most prominent commercial and business clusters could be found in the community of Koenigs-Wusterhausen. The west and north sides of the Schoenefeld community and the railway cross point in Grossbeeren could also be seen as evident commercial clusters.

The most obvious research and educational land use clusters could be seen at the railway cross points of the communities of Koenigs-Wusterhausen and Ludwigsfelde. Further, the most prominent sports and leisure land use could be found on the west side of the Schoenefeld airport, in the community of Blankenfelde-Mahlow and the south part of Mittenwalde.

Various conclusions could be drawn based on the density analysis of the land use features.

First, the attractiveness of economic development (real estate, ICT, retail, logistic, etc.) provided by the airport to its surrounding urban region is considered as an important determinant of whether an airport development will be successful. According to density analysis of other case study airports in the EU metropolitan regions, which have been expanded and developed under the modern airport and airport regional development strategies for years, have formed an obvious core of commercial and industrial land use clusters. The proportion of commercial, logistical, industrial and educational land use next to airports is much higher than in other communities of their host cities' suburban rings, being at some points even higher than in the urban region of their host cities. Nevertheless, according to land use analysis of the BER airport region, the commercial and industrial land use clusters are not very obviously close to the airport; instead, there are high residential land use clusters in the communities of Eichwalde, Schulzendorf and Zeuthen and even Blankenfelde-Mahlow in the closest sites surrounding the airport. This phenomenon indicates that, after the expanded BER airport starts operating, its impacts will greatly change the current land use structure of communities adjacent to the airport, and there is great potential for such communities to revitalize through airport-related industries. However, considering the highly clustered residential land use, especially on the east side of

the airport along the railway, there is not much available reserved land for further development of airport-related industries in these communities. This precondition should be noticed when making further development plans for the BER airport region.

Second, due to the advanced ground traffic network in the BER airport region, highly clustered industrial and commercial land uses are formed along highways and railways. In fact, the ground traffic network plays a more important role than the current Schoenefeld airport with regards to contributions to the regional economic development. The most evident is the industrial and commercial land use cluster in the community of Ludwigsfelde. This area is at both the cross point of motorway A16 with state road 101, as well as of Anhalter Railway and the railway from Schoenefeld to Potsdam. This place is also the cross point of the triangle linking Schoenefeld, the city of Berlin and the city of Potsdam. The superior location and ground traffic connections turn the place into the most prominent industrial and business region in the whole Berlin-Brandenburg suburban ring. There are also obvious industrial and commercial clusters in the localities of Grossbeeren, Wildau and Koenigs-Wusterhausen. Unlike other case study airports, all the above industrial and business land use cores are not directly located next to the Schoenefeld airport, but rather at the ground traffic crosses that have certain distance to the airport. Thus, before the BER airport starts operating, the superior ground traffic network provides greater contribution to the whole regional development than the operating airport Schoenefeld.

According to density analysis of other case study airports, the progress of an airport region commonly first occurs in an area that is close by the airport and the airport city. Next, an airport corridor linking the airport and its connected city will be formed with high density of airport-related industries, as well as large residential land use alongside sufficient service facilities. Then, not only the airport, but also the corridor will gradually expand to its surrounding region, and finally create a whole airport-related region. In other words, the development progress could be simplified as a “punctual-linear-planar” sequence (Figure 5-12).

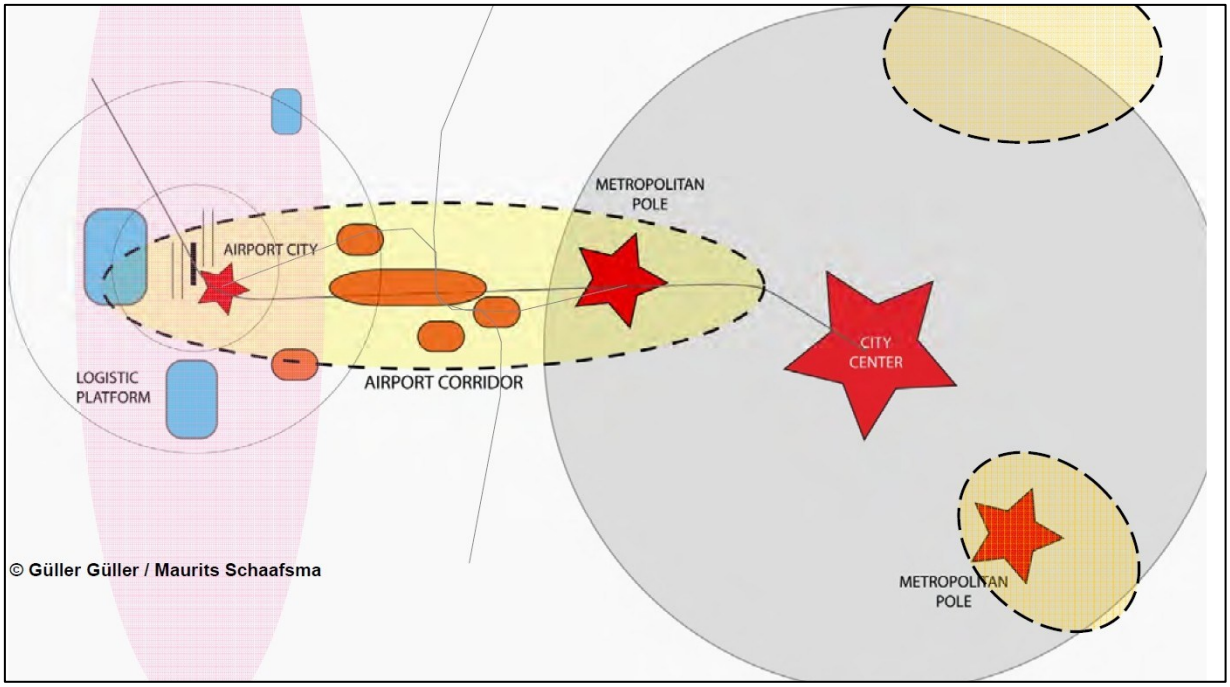

Figure 5-12 Airport Corridors - New Vectors of Economic Development of the Metropolitan Region
Source: "Airport Cities" and "Airport Corridors", Mathis Güller, www.ggau.net

Existing large-scale, developed industrial and commercial hot spots provide a better developmental precondition for the BER airport region at the beginning than was the case of other case study airports. According to the density analysis, unlike other case study airports, the ground traffic network in the BER airport region is denser, and the existing industrial and commercial land use hot spots provide a wider range of airport impacts on surrounding communities.

However, when comparing the resultant of the density analysis to the other case study airports of the EU, the current status of economic development in the BER airport region still has great potential under the impact of the BER airport. Currently, although there are great industrial and commercial clusters visible in the BER airport region, they are still shown as punctual "hot spots", and the development belt that links each hot spot is not formed yet.

5.3.3 Characteristic Industries in BER Airport-Surrounding Communities

A better understanding of characteristic industries present in the BER airport region is not only significant as a precondition for further regional economic development: It also plays an important role in enhancing the locality and urban/communities' identities. Indeed, the airport is a time-efficient traffic infrastructure that accelerates globalization and boosts airport-related industries. Nevertheless, it should be recognized that the further development

potential of the airport region is not only determined by the attractiveness brought about by the airport, but also based on the locality of both the airport-connected city and the airport region itself.

For example, the most successful airport region – that of the Amsterdam Schiphol airport – not only attracted airport-related industries such as aviation, ICT, retail, hospitality, etc., but also enhanced the traditional flower trading business in the area. Many international floral trade fairs, such as the World Floral Expo, have been held near the Schiphol airport region. Point-to-point floral delivery has been greatly promoted by the airport, as well as floral tourism. Such opportunities generated by the airport have greatly stimulated the local floral industry, and made the airport-neighboring community of Aalsmeer to the "wall street of flowers"[177]. Therefore, a preliminary study of the local economic development, especially traditional industries, is significant for making decisions in the further development plan of the whole airport region.

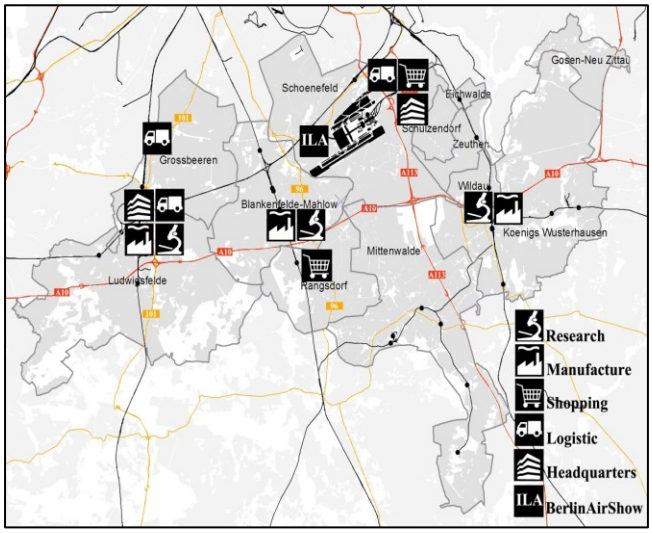

Figure 5-13 Existing Industries, Commercial and Logistic Clusters in the BER Airport Region
Source: By the author

Just as in other case study airports of EU metropolises, even though the BER airport has not started operating yet, due to its convenience many regional headquarters and research institutions of large international firms and logistics centers in the BER host city of Berlin are already relocating to the airport region. The new BER airport has also attracted many international companies to found new regional headquarters, consulting, research and test sub-branches.

Ludwigsfelde has the most prominent industrial, business and research cluster in the BER region. This community has a long history of machinery manufacturing industry, especially in the aerospace field. Daimler-Benz Motor Ltd. Hagen/Ludwigsfelde was founded in the community in 1936, and has 375 hectares of manufacture plant producing aircraft engines. The population of the community has also drastically grown according to the large

177 "It's blooming business in Aalsmeer, the Wall Street of flowers"
The Economic Times, accessed September 29, 2014, http://economictimes.indiatimes.com//articleshow/19826584.cms.

requirement of work force. During the GDR period, the VEB automobile plant in the community of Ludwigsfelde produced various rollers, such as the “Pitty”, “Troll” and also “Berlin” trucks. In the middle of the 1990s, the automobile plant in Ludwigsfelde produced “Vaneo” and “Vario” vans. The community started producing the new Mercedes-Benz Sprinter in June 2006.

Even though the incoming BER airport has not yet emerged, the airport impacts on economy are already visible, especially in Ludwigsfelde, which has a solid foundation of machinery manufacturing and a superior ground access to both the airport and the city of Berlin. The Ludwigsfelde industrial park nowadays has 256 hectares with over 70 companies. There are also three industrial parks in the community, such as the Brandenburg Park, Industriepark and Preussenpark, with a total area of 168 hectares and housing more than 900 companies engaged in diverse industries, such as logistics, metalwork, automotive/aviation/aeronautics, energy technology, ICT, life sciences, and trade and service business, creating 10,000 jobs.

Many large international companies have also relocated or founded their manufacture plants, research institutions, consulting and test sub-branches in the community of Ludwigsfelde under the impact of the incoming BER airport. For example, Siemens has invested 66 million Euro to found a combustion test center for gas turbines. The new test center, which is being built on a 36,000 m^2 site, will play a key role in advances and development of gas turbines. The major components of Volkswagen (VW) crafter vans will also be produced here. Completion is scheduled for October 2014[178]. The great automobile manufacturer VW also founded a new logistic and service and training center (Vertriebszentrum Brandenburg) of 120,754 m^2 in the year 2003. Gestamp Umformtechnik (GMF), which develops and produces car body and chassis components for the international car and utility vehicle industries, has founded a car-body manufacture as well as a tech and training center. The aircraft engine manufacturer MTU Berlin Brandenburg, which produces aircraft turbines and now the TP400-D6 engine for the Airbus A400M, has also established itself in Ludwigsfelde. Many large international companies such as Coca-Cola and ThyssenKrupp, and also many logistics companies have settled here as well. Since then, the community of Ludwigsfelde has turned into an important industrial center and has significantly contributed to the district of Teltow-Flaeming, being the most

[178] Siemens Lays Foundation Stone for New Combustion Test Center in Berlin, accessed on 14.01.2014, www. Siemens.com

successful business location in the state of Brandenburg.

Many existing industrial, commercial and research centers are also found in other communities of the BER airport region. In 2008, Rolls-Royce started building a new Mechanical Test Operation Center (MOTC) in Dahlewitz, Blankenfelde-Mahlow. MTOC required an investment of 65 million Euro and offers unequalled capabilities for Rolls-Royce's global operations in testing and evaluating the mechanical and structural behavior of gas turbine components. It provides testing capabilities across all business sectors for in-development, in-production and in-service engine programs. It employs 70 highly skilled engineers and technicians. In the 7,000-m^2 center, approximately 40 different tests can be carried out, ranging from centrifugal to operational stability tests, as well as vibration and materials testing. MTOC officially opened in May 2010 and became fully operational in 2011[179].

Close corporation of the company and the municipality is significant for expansion of current developments. For example, the municipality in cooperation with Rolls-Royce provides a daycare center service offer until 10.00 p.m., even on Saturdays. Such service generates great acceptance by the drawn families. Multilingual kindergartens and primary schools are also available according to the requirements of employees from Rolls Royce. Such progress has enhanced the cooperation between the locality and companies, and also satisfied inhabitants. As a result, from the year 2014, a total of 90 million Euro will be invested in the expansion of the existing on-site testing laboratory system, so the largest and most powerful Rolls-Royce engines – the XWB engine with 97,000 pounds of power, which is the most efficient large civil engine in the world – can undergo development assessments in the test center of Blankenfelde-Mahlow.

A large logistic center – Freight Village Berlin South – was founded in the community of Grossbeeren due to superior location and convenient ground traffic connections. It is situated at the cross of the motorway A10 and the state road 101, and connected to the national roads L40 to Potsdam and L76 to Schoenefeld Airport. It also has connections to the railway to the south (Halle, Leipzig, Munich) and the Berlin outer rail ring. It is only 5 km far from Berlin, 15 km from Potsdam and 20 km from the Schoenefeld Airport. It is not only the major freight interchange terminal in Berlin, but also among the Top-10 logistic centers in whole Europe, being operated by 66 logistical companies and providing

[179] Rolls-Royce opens state-of-the-art Mechanical Test Operations Centre in Germany, accessed on 15.01.2014 , www.rollsroyce.de

more than 5,000 work places. It has a total area of 260 hectares, as well as 65 hectares of settlement area that has been planned[180].

There is also a potential developmental hot spot in Blankenfelde-Mahlow, which will have great opportunities under the future impact by the BER airport – the Berlin Air Show (Internationale Luft- und Raumfahrtausstellung ILA). The ILA was first held in Frankfurt am Main in 1909, and is thus recognized as the world's oldest air show in the world[181]. Before World War I, the ILA was held in Berlin (in 1912, and later in 1928). When Germany regained air sovereignty after World War II, the foundations were laid in 1955 for an "International Show for Travel by Air", which in 1957 took place at Langenhagen Airport as part of the Hanover Trade Fair, the first in a run of ILA shows in Hanover that was to last over 30 years. In 1992, after the fall of the Berlin wall, the ILA returned to Berlin, its birthplace. It combines a major trade exhibition for the aerospace and defense industries with a public airshow. It is held every year at the Berlin Expo Center Airport near Schoenefeld, 18 km southeast of Berlin. The main section of the grounds covers approximately 250,000 m^2[182]. It is among the largest and most important aerospace trade fairs today. According to the organizer Messe Berlin GmbH, in 2012 the Berlin Air Show attracted 125,000 professional visitors and 105,000 members of the general public, with 3,600 journalists from 65 countries also attending[183].

In the knowledge economy era, regular events may not only bring great development opportunities for urban economy for the whole city, but also become the new hot spot to revitalize the surrounding urban region. For example, the Milan Fashion show has not only rebooted the traditional fashion industry and promoted the city as the top design and creativity city in the world, but also revitalized the whole region where the event is held, which a brown field was lacking vitality, facing high unemployment rates and losing young labor force.

The Berlin Air Show ILA, as the oldest air show in the world and one of the largest and most important aerospace trade fairs today, may also bring great developmental opportunities to its surrounding urban region. However, according to the analysis of

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[180] Berlin-Brandenburg als Hub im Seehafenhinterlandverkehr Marketing, accessed on 15.01.2014 , http://gleisanschluss-brandenburg.de

[181] ILA Berlin Air Show, Accessed on 15 January 2014, www.visitberlin.de

[182] ILA Berlin Air Show, Accessed on 15 January 2014, www.visitberlin.de

[183] ILA, accessed on 15 January 2014, www.ila-berlin.de

existing land use distribution in the ILA region and the experience of ILA visitors, there is not sufficient hospitality support yet that could afford the demand of visitors. The thematic event still has room for improvement to enhance the urban branding of its locality as a traditional aerospace industrial region. Large proportion of visitors and exhibitors from across the globe has to ride back to Berlin for accommodations, because there are insufficient hotels and other service facilities in the ILA region. Therefore, after the new BER airport starts operating, because of its convenient connection to the world, it may greatly promote the urban economy not only by providing more opportunities to the local traditional aerospace industries, but also by enhancing the hospitality and tourism industry in its surrounding urban region.

For the communities to the west side of the BER airport, the major industrial, commercial and research clusters are formed at the so-called Schoenefeld's Cross (Schoenefelder Kreuz), composed by the localities of Schoenefeld, Wildau and Koenigs-Wusterhausen.

Schoenefeld, the host community of Schoenefeld airport and the future BER airport, currently still have large reserved land for future development. At present, the community of Schoenefeld houses several sub-branches of airline operators, such as Lufthansa Bombardier Aviation Services GmbH and Lufthansa Technik AG. There is also one large furniture center, the "Einrichtungs-Center Waltersdorf", next to the airport and along the motorways A113 and A117. It was founded in 2004, has an area of 82,000 m^2 and 2,000 employees. There are 15 large traders and wholesalers in the area, such as IKEA, Media Markt, Kibek, etc., and attracts more than 7 million customers yearly according to the statistics of the municipality of Schoenefeld[184].

The mechanical engineering put the community of Wildau on the map as a location for industry. In 1897, the Schwarzkopf GmbH established a locomotive factory here and built housing for the factory workers that are today a cultural heritage in the community. After German reunification, the factories were mostly shut down, and the community then urgently needed transformation of their polar industries. After several years of redevelopment, the community, together with its neighboring community of Koenigs-Wusterhausen, has attracted numerous firms of diverse branches thanks to its good industrial basis, good ground traffic conditions and the nearby future BER airport. These two communities now host various firms such as automotive, biotechnology/life science, logistic, aerospace technology, ICT and metal work and machinery manufactures,

[184] Gewerbegebiete Einrichtungs-Center Waltersdorf, accessed on18 January 2014, www.gemeinde-schoenefeld.de

as well as the large shopping center A10. Heavy industry and mechanical engineering, such as the Wildauer Schmiedewerk GmbH (a steel plant), Gröditzer Kurbelwell GmbH (machine tool manufacture), SMB Schwermechanik GmbH (heavy mechanic manufacture), which follow their community's mechanical industrial tradition, have been founded in old industrial areas. Logistic centers such as Lutra Logistic have been founded here owing to the good ground access preconditions. In 1991, the Federal State of Brandenburg founded the Technical University of Applied Sciences of Wildau, which was based on the old engineering school founded in 1949. The Brandenburg College of Finance was also established in the community of Koenigs-Wusterhausen in 1991. Wildau and Koenigs-Wusterhausen have also attracted several aerospace technology companies, such as AneCom Aero Test GmbH and FTI Group. The A10 shopping center at the cross of the motorways A10 and A117 have a number of 200 retail and related service firms that have a large shopping area of about 66,000 m^2 and provide 36,000 free parking spaces.

The BER airport region also has a large area of natural landscape parks and a number of recreation and leisure facilities, like a golf and riding courts, which provide great potential for further tourism and recreation developments that attract tourists and inhabitants, once the BER airport starts operating.

5.3.4 Prediction of the BER Airport Impact on its Adjacent Communities

As the sole air gate to the capital region of Berlin, when the BER airport is opened, it will greatly impact the encircling urban region. The impacts of the BER airport responding to urban development will be shown next.

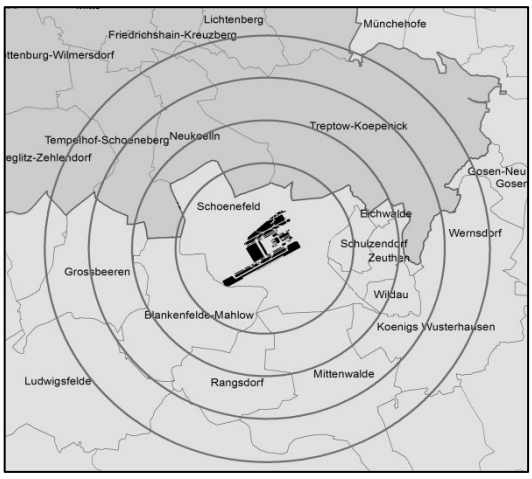

Figure 5-14 Research Scopes of BER Airport Region, take 6, 9, 12 and 15 km as Radius and Airport as Centers
Source: By the author

Another direct result of the BER Airport expansion will be the variation of land use composition in its surrounding communities. The airport will inevitably attract airport direct, indirect and induced companies to relocate into its surrounding urban region. According to analysis of land use distribution features in Chapter 3, each land use, such as industrial, residential, commercial, educational/research and sport/leisure, will be impacted by the distance to the airport, airport capacity and the number of employees, which could serve as basis for prognoses on the changes of land use

composition in the BER airport region. In order to analyze land use distribution features within different scopes, the research scope is considered as circles, which takes airport as the center points, and with a radius of 6, 9, 12 and 15 km. (Table 5-2).

Berlin Airport Region	Commercial %	Residential %	Industrial %	Educational %	Sport %
6 km Radius Circle	1.7475	11.3335	1.7751	0.1190	1.4575
9 km Radius Circle	1.7043	26.1418	1.7263	0.4022	1.0437
12 km Radius Circle	1.8492	23.5751	2.3064	0.5485	1.2300
15 km Radius Circle	1.8987	22.9756	2.6095	0.5022	1. 0650

Table 5-2: Statistics of Land Use Proportion Scopes of 6, 9, 12 and 15 km Radius Circle With BER Airport at the Center
Source: By the author

■ Comparison of Land Use Composition of BER and Other Case Study Airports

Figure 5-15 shows the proportions of different types of land use in case study airport regions and the BER airport region within scopes of circles with airports as centers, and with 6, 9, 12, 15 km radius.

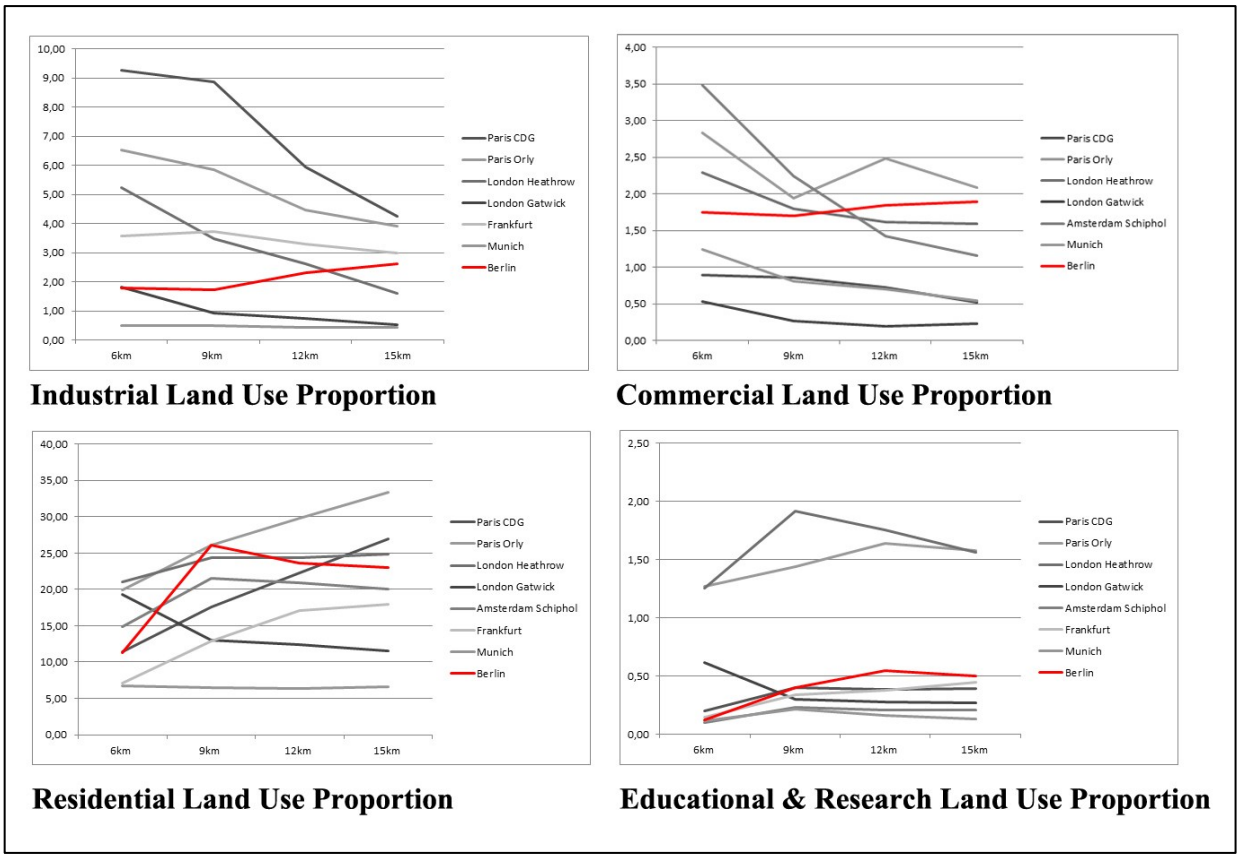

Figure 5-15 Land Use Distributional Proportion in Scopes of 6, 9, 12 and15 km Radius of Case Study Airport Regions and BER Airport Region
Source: By the author

According to the figure showing industrial land use composition, the peak value of industrial land use distribution featured in other case study airports are clustered at the

scope of 6-9 km radius circles around airports. From 9 km, the proportion of industrial land use starts to decrease. However, in the current BER Airport, the tendency of industrial land use distribution is contrary to other case study airports. The industrial land use from the 9-km radius scope starts increasing, and the lowest industrial land use distribution value is in 6-9 km. Compared with other case study airports, before the opening of the BER Airport, the industrial development in the 9-15-km radius scope is already higher than Munich Airport and London Gatwick Airports, and even Heathrow airport, although the starting capacity of the future BER Airport is much lower than of these three airports. This indicates that before the BER officially starts operating, the proportion of industrial land use is already higher than in these three airports in 9-15-km scope. The airport-related industrial basis is already formed surrounding the BER airport, which will provide a better precondition for it to develop aviation-related industries in its surrounding region. Furthermore, according to the tendency of industrial land use distribution in other case study airports, there is still large potential for the BER airport to develop its related industries in the scope of 6-9 km.

According to the study of commercial land use distribution, its common peak value is found clustered in the scope of 6 km to the airport. The proportion of commercial land use distribution in other case study airport starts decreasing from 6 km distance to the airport and farther. However, in the BER region, the peak value of the proportion of commercial and business land use distribution is not at the 6 km, but starts increasing from the 9 km distance to the airport to a broader scope. Compared with other case study airports, the proportion of BER Airport region's commercial land use within 9-15 km distance to the airport is higher than in London Gatwick, Munich and even London Heathrow airports. This means that, in such scope, the commercial atmosphere is already formed, which will provide a good basis to develop commercial and business land use in the BER-encircling urban region. Moreover, according to the common tendency of commercial and business land use distribution, there is still great potential for the BER Airport to develop its related commercial and business land use in the 6-km scope distance to the airport.

The common residential land use distribution is inversely proportional to the distance to the airport: The larger the distance to the airport, the higher the proportion of residential land use. However, in the current BER region, the highest point of residential land use proportion is clustered at 9 km distance to the airport. From the 9 km to 15 km distance, the proportion of residential land use starts decreasing, and the proportion of residential land use within 9 km distance to the airport is even the highest in statistics of all case study

airports. The population or the residential land use in the closest set of BER Airport region is denser than in other case study airports, which means that the airport noise contour in the BER airport region will cover more residential area and impact more residents. Thus, the airport noise impacts should be considered more seriously in the BER airport region, and the costs for noise protection programs in this region shall be more than in other case study airports.

From the study of higher educational and research land use proportion, one could recognize that there is a larger proportion of research and educational land use in the BER airport region than seen in other case study airports, except for Paris Orly and London Heathrow. Currently, the BER Airport region has good basis for higher educational facilities. Moreover, the existing research or higher educational facilities have already provided an image of research and high-tech region, especially in the aerospace industry, which could be an advantage to attract airport-related industries to settle here.

- **Adjustment of Land Use Distribution in BER airport cities**

The above land use distribution figures clearly show that aviation-related industrial development is already formed in the existing BER airport region, even though the airport is still officially not opened. The industrial and commercial land use proportion in the BER airport region is even higher than in some large European hub airports with higher capacities, which provides a good foundation for further development in the BER airport region. However, according to previous study of land use proportions of each community, one could detect a large variation of proportions of land use distribution between each community. Therefore, to utilize the airport as opportunity to balance the land use distribution structure in the BER airport region should be even more urgently handled in the airport regional planning, to promote competitiveness of the whole region rather than several certain communities.

However, considering the future planning (GSK FU BBI) of the BER airport region, one could find that a sole development belt has been planned along the BER-Berlin-Treptow Corridor. Not only the BER business park (157 ha), but also Berlin's largest business zone – the Adlershof Business Park (420 ha) – will be expanded along the traffic corridor. Compared to this grand development plan of the axis, the west side of the BER airport region, e.g. Landkreis Teltow-Flaeming, which lies directly in between the BER-Potsdam Corridor, and the communities of Blankenfelde-Mahlow and Ludwigsfelde, which have the most prominent geographical advantage for further development, have not been emphasized. Compared to the larger planning in the Berlin direction, the development of

BER-Potsdam corridor lacks efficient public investments (projects), and it may cause:

1. Imbalance in the urban development of the airport region. A successful development project could be that of the Orly Airport region, the west part of which shows medicine-related developments, while the southeast part presents fruit and vegetable logistic clusters. Each sub-region has a clear and balanced development progress. Also the Amsterdam Schiphol has formed a geographically multidirectional development model, with the direction of development leading both to Amsterdam Westport (North), Aalsmeer (South) and the Schiphol-Haarlem Corridor.
2. Monotonous land use will need more supportive urban facilities and lead to another round of urban expansion (residential area, shopping, health care). South Berlin is already urbanized and lacks reserved land for further development. Excessive urban expansion will cause eco-disruption in the surrounding Spree forest's natural landscape, and may increase the development differences between east and west sides of the airport.
3. Development along the sole traffic corridor may cause traffic congestion, because the principal passenger flows of the BER airport from/to the city of Berlin mainly depend on ground traffic access along the BER-Treptow corridor. Therefore, if large-scale urban development projects are mainly planned along this corridor, it may cause traffic congestions. Airport passengers, employees and also a large number of employees working in business parks along the traffic corridors will have to share the limited public transportation system.

5.3.5 Prediction of Land Use Development Hotspots in BER Airport Region

Like investigation on other case study airports, a hotspot analysis which took industrial, commercial, residential, research, higher educational as well as sport and recreational land use as research objects have also been made in order to explain the status quo of each land use distribution in BER airport region.

Unlike density analysis, to be one hotspot, a feature should have a high value and be surrounded by other features with high values as well. The local sum for a feature and its neighbors is compared proportionally to the sum of all features. Therefore, the hotspot analysis resultants could not only show current land use clusters, but also shows the

clustering tendency in a more precise way.

The scope of the analysis includes 12 communities surrounding the new BER airport region. All facilities in such scope are combined within a 600m fishnet for the hotspot analysis. The resultant is as follows:

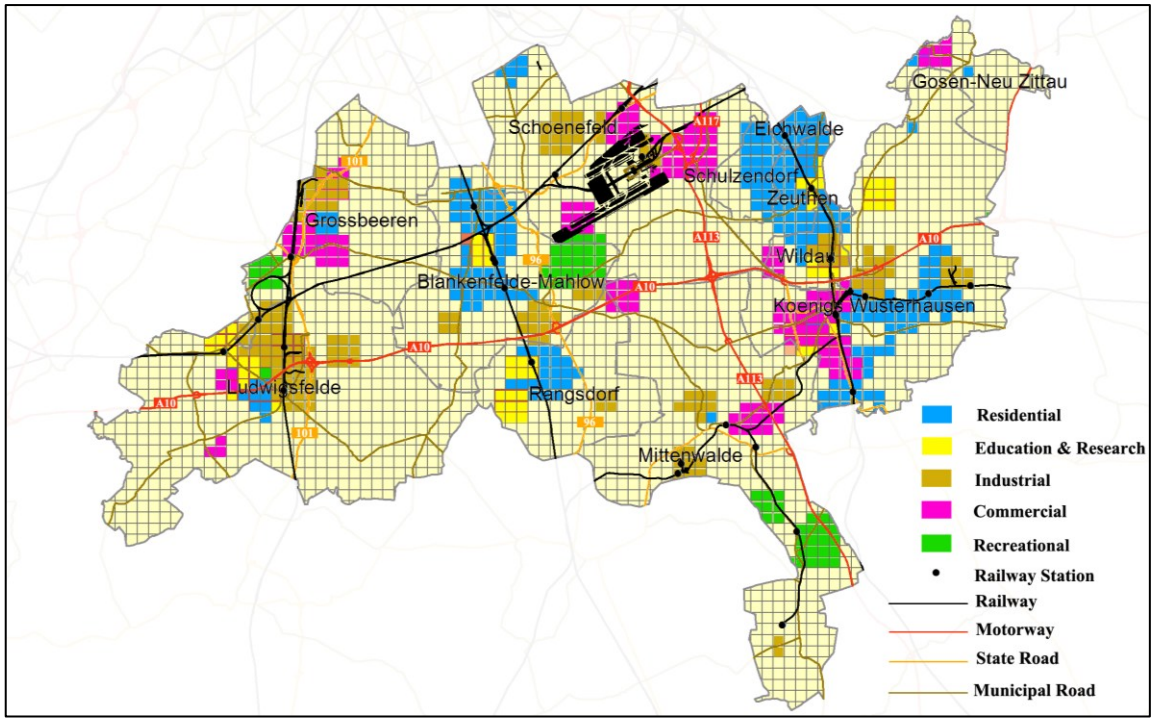

Figure 5-16: Hotspot analysis of BER airport region
Source: By the author

The purpose of the study is to take the above hotspot analysis resultants, and integrate with major impact factors of land use distribution in airport region, which was studied in chapter three (regression resultants, airport location, noise contour, ground traffic networks, interrelation between land uses) as preconditions in predicting the clustering tendency of each land use in BER airport regions.

■ Industrial Land Use Development Hotspot in BER Airport Region

According to regression analysis of industrial land use distribution in airport region, an established regression model has been found that the industrial land use distribution is closely correlated with the number of annual air cargo tonnes. The tendency of industrial land use distribution in airport region is also between found within scopes of six, nine, twelve and fifteen kilometers distance to the airport.

According to the comparison of the industrial land use distribution tendency by distance to the airport and the industrial land use distribution status in BER airport region, we could found:

First, when take the summed cargo volume of Tegel and Schonefeld airport in 2013 as explanatory variable x, and take the industrial land use volume as dependent variable y, the total value of existing industrial land use in BER airport region is already higher than predicted resultant of the established regression model. However, although the total volume of the industrial land use in BER airport region is higher than regression resultants, but the distribution tendency differently with the common industrial land use distribution tendency of eight case study airport. Unlike the other case study airports, the peak value of the industrial land use distribution is not at the scope of zero to nine kilometers to the airport, but locates at the scope of 12 to 15 kilometers distance to the airport. According to this scenario, we could conclude that: First, although the BER airport is still not opened, but the airport-related industrial lands use clusters are already clusters at the airport vicinity. However, there are still potential for industrial land use development, in other word, more industrial facilities will clusters at the closet scope (0 to 9 kilometers to the airport) of the new BER airport. Therefore, several communities (e.g. Blankenfelde-Mahlow, Schonefeld) which locate next to the new airport may share more opportunities in attracting industrial development under the impact of the new BER airport.

Second, as has been stated in the chapter 3.4, if the location of an airport is considered as the impact factor of urban development, then considering airport that locates in a city circle and serves not only the connect major city but also a cities in the metropolitan region, then the airport impacts on urban development is maximally. The urban regions between not only the airport to the host city, but also the urban region nearby the ground traffic network from the airport to other cities will also grow to be the airport-related urban region.

For BER airport, it is in the situation between “airport at the city edge” and “airport at the city circle”. Therefore, if it is intends to develop the BER airport region with higher profits and industrial development in a larger scale, then it is necessary to consider not only the Berlin-BER corridor as the industrial development hotspot, but also communities in between the traffic connections of BER to other cities (Potsdam, Cottbus, etc.) of the Berlin-Brandenburg Metropolitan Region.

Third, according to 3.6.2 “Hot Spot Analysis of Airport Noise and Ground Traffic Impact on Land Use Distribution”, compare to commercial land use that mainly clusters around the airport, the industrial land use distribution is more dispersed. Meanwhile, the potential industrial hotspots must have good connections with both passenger rail and highway joints. Unlike residential land use and other noise sensitive facilities, the industrial land use could be arranged within the noise contour. Thus it is possible to fill in the blank of noise

contour by industrial facilities. Moreover, unlike commercial, residential and other land uses, which developments will are supported by a certain number of service people and should locates nearby residential land use. Controversially, the communities' population is not an influencing factor for industrial land use clusters. Considering interrelation between each land uses, the locating of industrial land use is more flexible than setting other land uses.

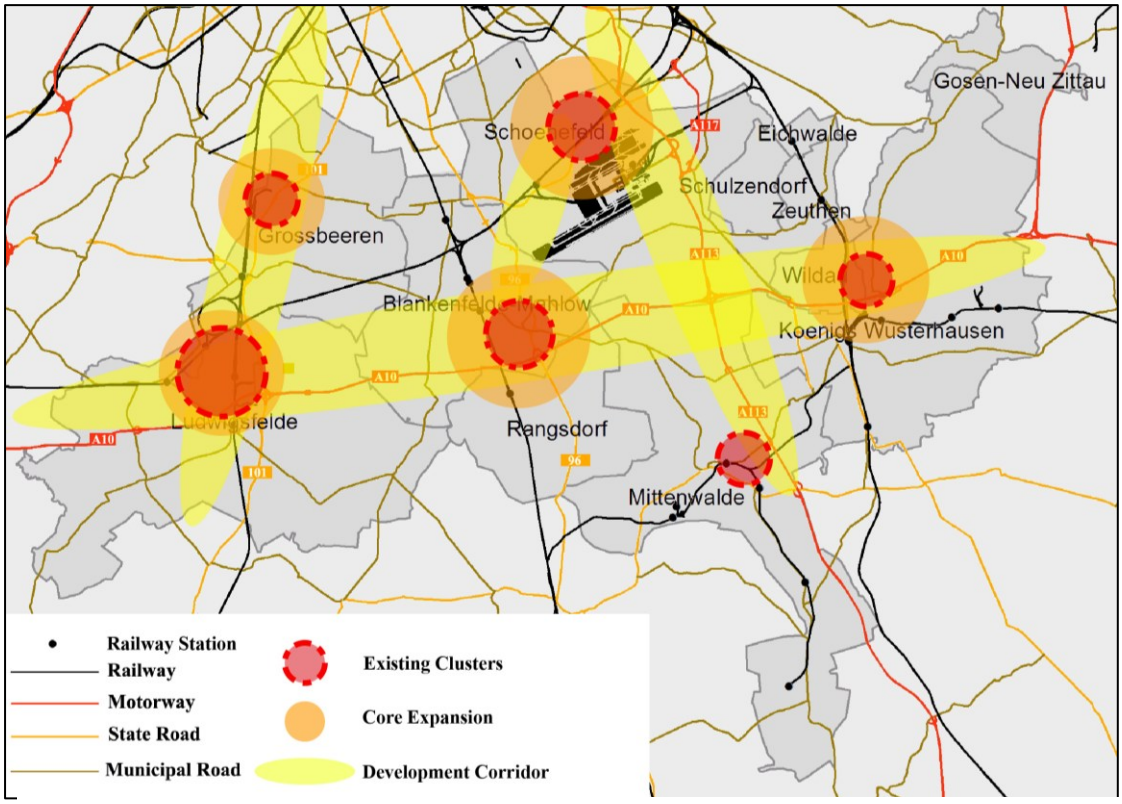

Figure 5-17: Industrial Land Use Development in BER Airport Region
Source: By the author

Figure 5-17 shows the current industrial land use clusters, possible industrial expansions as well as development corridors. According to hotspot analysis of BER airport region, the largest industrial land use hot spots is shown in the community of Ludwigsfelde. Meanwhile, the industrial land use clusters are also formed in communities of Grossbeeren, Blankenfelde-Mahlow, Schoenefeld and Königs-Wusterhause.

According to previous study of industrial land use distribution by distance to the airport, we could conclude that the density of industrial land use is conversely to the distance to the airport, which means the shorter the distance to the airport, the denser the industrial land use is. In BER airport region, although industrial land use clusters is already formed in the community of Ludwigsfelde, Blankenfelde-Mahlow, Schoenefeld etc., but the tendency of industrial land use distribution still could not be seen in the BER airport region. The

current largest industrial cluster is located in the community of Ludwigsfelde, which is distant to the airport, and took a large proportion of the total area of industrial land use in BER airport region. Therefore, according to industrial land use distribution tendency by distance to the airport, there are still large potential of industrial development in communities in the more close scope of the new BER airport region, such as Blankenfelde-Mahlow, Schönefeld etc. Therefore, the community of Blankenfelde-Mahlow, Schönefelde as well as Königs-Wusterhausen is considered as existing industrial clusters with most high potential of expansion.

According to study of ground traffic impact on industrial land use distribution, the ground traffic linkages from communities to the airport, as well to the city plays an important role in industrial land use development. Meanwhile, as the resultant of the previous density analysis shows, one precondition of industrial land use development is the area must have both efficient railway and highway linkages. Moreover, according to study of airport location impact on airport region development, the impact scope of airport would be much larger when consider the airport locates in a metropolitan region, rather than just consider the urban development between the airport and its connected city. Therefore, for the BER airport, the urban development corridor should not be considered as the traffic linkage between Berlin and the airport, but the railway and highway corridor between the airport and the city of Potsdam and other cities in Berlin-Brandenburg Metropolitan Region should also be considered as the new urban development corridor. Therefore, the new industrial development corridor is defined as from Mittenwalde to Berlin, from Ludwigsfeld to Berlin as well as from König-Wusterhausen to Potsdam.

- **Commercial Land Use Development Hotspot in BER Airport Region**

According to regression analysis of commercial land use distribution in airport region, an established regression model has been found that the industrial land use distribution is closely correlated with the number of annual airport passenger number. The tendency of commercial land use distribution in airport region is also between found within scopes of six, nine, twelve and fifteen kilometers distance to the airport.

In accordance with the comparison of the commercial land use distribution tendency by distance to the airport and the commercial land use distribution status in BER airport region, we could found:

First, when take the summed airport passenger number Tegel and Schonefeld airport in 2013 as explanatory variable x, and take the commercial land use volume as dependent variable y, the total value of existing commercial land use in BER airport region is

already higher than predicted resultant of the established regression model. However, although the total volume of the commercial land use in BER airport region is higher than regression resultants, but the distribution tendency differently with the common commercial land use distribution tendency of eight case study airport. Unlike the other case study airports, the peak value of the commercial land use distribution is not at the scope of zero to six kilometers distance to the airport, but the most obvious airport-related commercial clusters are still not formed in the close scope of the BER airport. According to this scenario, we could conclude that: First, although the BER airport is still not opened, but the airport-related commercial land use is already clusters at the airport vicinity. However, there are still potential for commercial land use development, in other word, more commercial facilities will clusters at the closet scope (0 to 6 kilometers to the airport) of the new BER airport. Therefore, several communities (e.g. Blankenfelde-Mahlow, Schonefelde) which locate next to the new airport may share large opportunities in attracting commercial development under the impact of the new BER airport.

Second, according to 3.6.2 “Hot Spot Analysis of Airport Noise and Ground Traffic Impact on Land Use Distribution”, the most obvious commercial land use cluster that mainly locates at the airport. Meanwhile, the potential commercial hotspots must has good connections with both passenger rail and highway joints, Therefore, urban space surrounding each railway stations of the airport region are all sharing the opportunity to development as a new commercial cluster. Unlike residential land use and other noise sensitive facilities, the commercial land use could be arranged within the noise contour. Thus it is possible to fill in the blank of noise contour by commercial facilities. Moreover, commercial developments will are supported by a certain number of service people and should locates nearby residential land use. Therefore, each community center in BER airport region has the opportunity to become the new commercial cluster of the BER airport region.

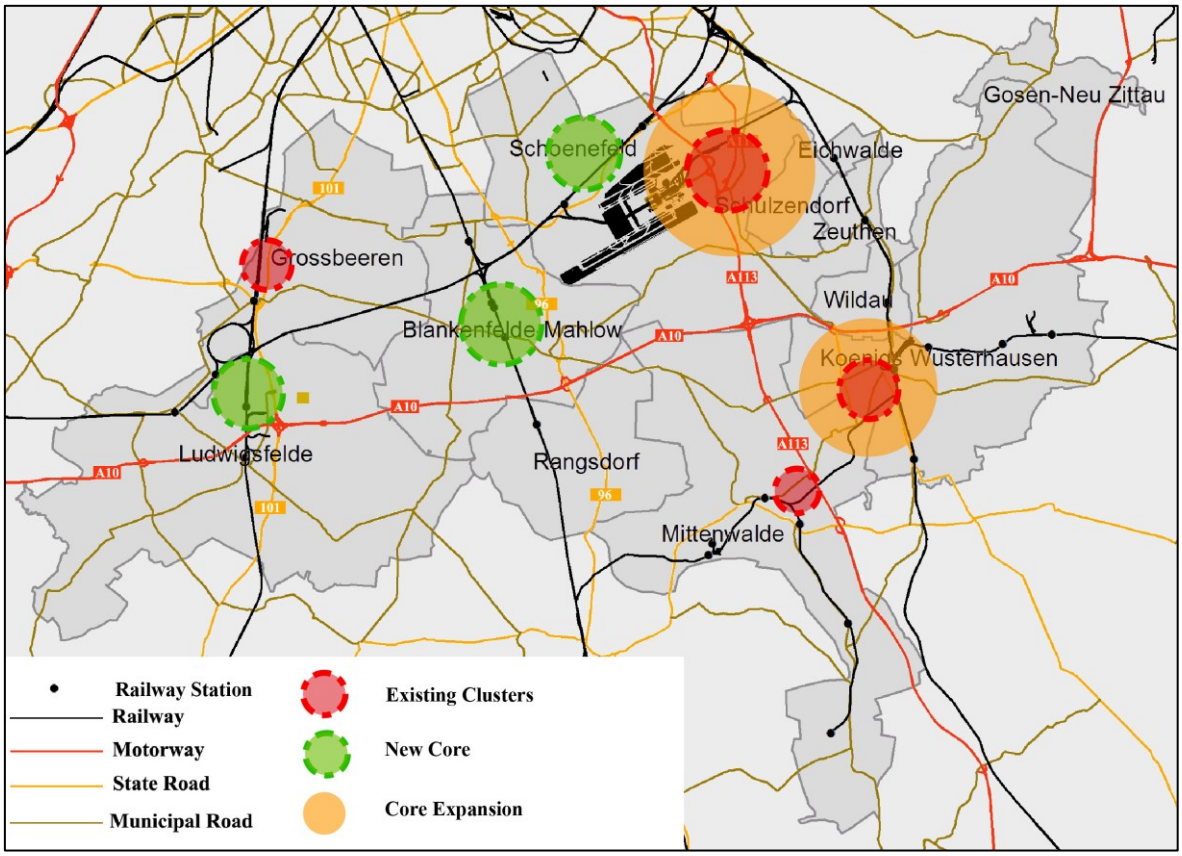

Figure 5-18: Industrial Land Use Development in BER Airport Region
Source: By the author

Figure 5-18 shows the current commercial clusters, possible commercial expansions as well as place of new commercial cores in future airport regional development. According to hotspot analysis of BER airport region, currently the obvious commercial clusters are still not formed in the BER airport region; several secondary commercial cores are dispersed in community of Schoenefeld, Königs-Wusterhausen and Grossbeeren.

According to previous study of commercial land use distribution by distance to the airport, we could conclude that the peak value of commercial land use commonly clusters at the closest urban region surrounding the airport. The airport impact on commercial development will sharply decrease from six kilometer to exterior. Therefore, in accordance with commercial land use distribution tendency by distance to the airport, there are still large potential of commercial development in communities in the more close scope of the new BER airport region, such as Blankenfelde-Mahlow, Schönefeld etc. Therefore, the community of Blankenfelde-Mahlow, Schönefelde is considered as new commercial clusters with most high potential of expansion.

According to study of ground traffic impact on industrial land use distribution, the ground traffic linkages from communities to the airport, as well to the city plays an important role

in commercial land use development. Meanwhile, as the resultant of the previous density analysis shows, one precondition of commercial land use development is the area must have both efficient railway linkages. Meanwhile, commercial land use is correlated with residential land use. In other words, not only airport passengers, but also increasing residential density will also somehow increase the commercial development in each community surrounding the BER airport.

5.4 **Noise Impact on the BER Airport Region**

When BER starts operating, more frequent aircraft movements will obviously cause more serious noise impacts on airport-surrounding communities. According to the operator of the BER Airport, in 2012 the aircraft movement in Berlin Schoenefeld Airport was of 71,775 machines[185]. This includes 64,075 aircraft movements at daytime (06.00 a.m. – 10.00 p.m.) and 7,700 by night (10.00 p.m.–06.00 a.m.). But after the opening of the BER airport, the aircraft movements will drastically increase to 277,588 (without helicopter movements), including 262,239 aircrafts at daytime and 15,349 at night[186]. Therefore, the annual aircraft movements in 2015 will be around four times more frequent than in 2012, and twice as often at night time. Moreover, according to a prediction study of BER aircraft movements[187], in 2023 these will increase to 319,000, being 28,068 aircraft movements at the night time and 290,032 at daytime.

	Average Aircraft Movements/Day			Average Aircraft Movements/Year		
	Day	Night	Sum	Day	Night	Sum
2012	176	21	197	64,075	7,700	71,775
2015	718	42	761	262,239	15,349	277,588
2023	797	77	874	290,032	28,068	319,000

Table 5-3 Current and Predicted Airport Movements of BER Airport

Source: By the author according to statistics of Land Brandenburg Ministerium für Umwelt, Gesundheit und Verbraucherschutz

The noise abatement program „Schallschutzprogramm BBI“ was approved in 2009 to reduce night flights (from 10.00 p.m. to 06.00 a.m.) for the future BER Airport, and even

[185] Umweltbericht 2012, FBB Flughafen Berlin Brandenburg, accessed on 20,01,2012 , www.berlin-airport.de

[186] Christian Maschke, *Umgebungslärmkartierung Brandenburg 2012-Flughafen Berlin-Brandenburg* (Landsamt für Umwelt, Gesundheit und Verbraucherschutz, January 2013).

[187] *Ausweisung des Lärmschutzberichs nach dem Gesetz zum Schutz gegen Fluglärm(FlugLSG)-Flughafen Berlin Brandenburg* (Potsdam, Germany: Land Brandenburg Ministerium für Umwelt, Gesundheit und Verbraucherschutz, July 2013).

forbid night flights between 12.00 a.m. and 5.00 a.m. However, the night flight problems could not be solved only by this program, because all night flights of the BER Airport will only be allowed from 10.00 p.m.–12.00 a.m. and 05.00 a.m.–06.00 a.m., and the flight frequency in these three hours is high and could still have great impacts on local residents. Observing the prediction of 2015 aircraft movements in the BER Airport as an example, the estimated night flight in 2015 will be 15,349, and on average 42 movements night and 14 movements per hour. This means that local residents will be disturbed by landing/taking-off aircraft noise in the Airport every four minutes from 10.00 p.m.–12.00 a.m and 05.00 a.m.–06.00 a.m. Such frequency is even higher than aircraft movements at daytime (06.00 a.m. – 10.00 p.m.) at the current Schoenefeld Airport in 2012 (11 flights per hour). When estimation was made that 28,068 night flights will be operated in 2023, the landing/taking-off frequency during such three hours will be as high as 26 per hour and local residents will be disturbed by aircraft movements every two minutes. Such frequency is more than two times higher than the current daytime landing/taking-off frequency in Schoenefeld Airport. Therefore, we could consider that the noise abatement program in BER Airport is significant to protect residents from airport impact at night time. However, to protect residents only by such program is by far not sufficient.

After the opening of the BER Airport, the operation of a second runway as well as new landing of larger aircrafts will cause an enlargement of the noise impact contour in the BER Airport region. The area of $L_{DEN} \geqslant 55$ dB(A) noise contour of Berlin Schoenefeld Airport in 2010 was about 55 km^2. According to prediction of noise impact in 2015, the BER Airport noise contour will increase to about 116 km^2 [188]. Thus, the area of $L_{DEN} \geqslant 55$ dB(A) noise contour of the BER will be more than twice as large as Schoenefeld in 2010. Currently, there are 15,700 residential units and 20 school building in the future 2015 BER Airport's L_{DEN} 55-60 dB(A) region, and 100 residential units in the L_{DEN} 60-65 dB(A) region. The population in the 2015 BER Airport's L_{DEN} 55-60 dB(A) region will be of 30,200, and 8,400 people living in the L_{DEN} 60-65 dB(A) region. There will also be 300 people living in the L_{DEN} 65-70 dB (A) region. Therefore, the opening of the BER Airport will increase the noise impact on local communities not only by aircraft movements, but also by enlarging the impact scope[189].

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[188] *Ausweisung des Lärmschutzberichs nach dem Gesetz zum Schutz gegen Fluglärm(FlugLSG)-Flughafen Berlin Brandenburg* (Land Brandenburg Ministerium für Umwelt, Gesundheit und Verbraucherschutz, July 2013).

[189] Strategische Lärmkartierung gemäß Richtlinie 2002/49/EG im Land Brandenburg - vorhersehbare Lärmsituation 2015 - Flughafen BER ,Wölfel Messystem Software Gmbh Report to Land Brandenburg. 27 November 2012

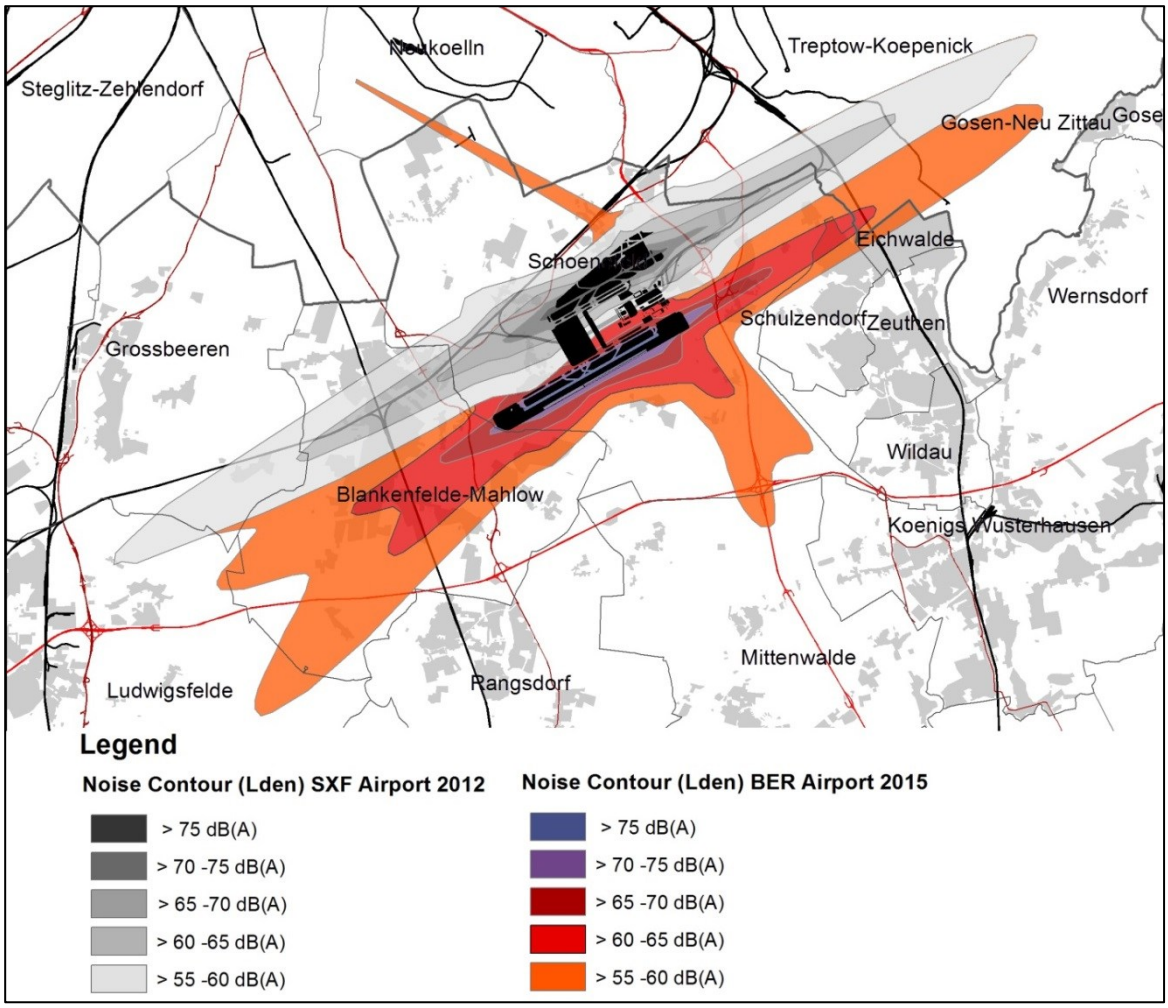

Figure 5-19 BER Noise Contour (Lden) Expansion 2012 to 2015

Source: By the author according to "Strategische Lärmkartierung gemäß Richtlinie 2002/49/EG im Land Brandenburg"

Aircraft noise is now becoming the major reason for local residents to protest against the development of the BER Airport. A survey made by the Goettingen Institute fuer Demokratieforschung[190] indicates that 96% of the total 708 respondents who live in the BER Airport region are opposed to the planned flight routes of BER Airport. In addition, 98% of the respondents think the decision maker of the BER Airport development pays insufficient attention to the interests of residents. Further, 93% of the total 708 respondents think that airport noise of the expanded BER Airport is the major reason for local residents to protest against the expansion project. They also believe the aircraft noise will drastically decrease the land value of their property, as well as cause damage to health and living quality of their communities. Therefore, 14.5% of the total 708 respondents have already

[190] Becke, Ana, Franz Hartmann, Christoph Hermann, Lea Heyne, and Christoph Hoeft. *Protests Against the Berlin Brandenburg Airport (in German)*. Göttingen Germany: Göttinger Institut of Demography, August 2011.

participated in social protest actions (in the form of demonstrations, petitions, etc.).

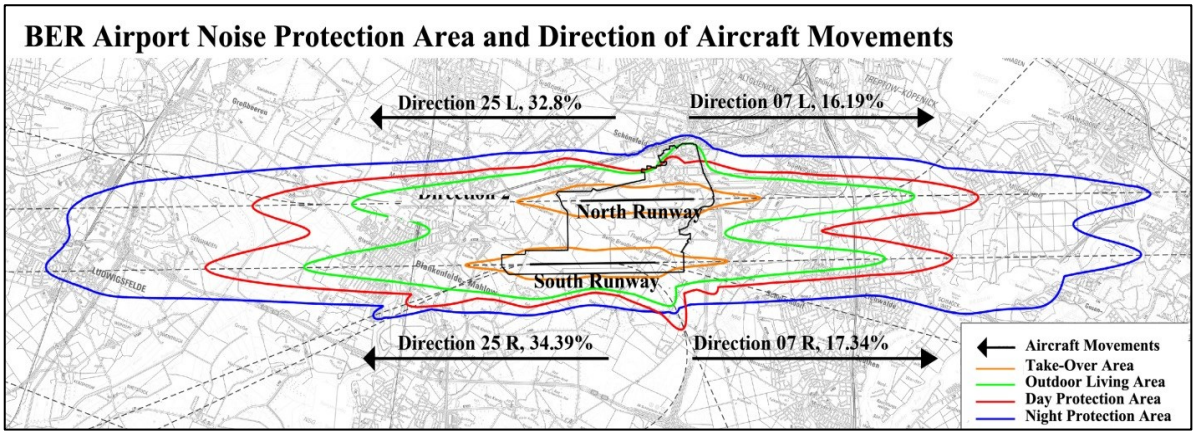

Figure 5-20: BER Airport Noise Protection Area and Aircraft Movement Direction 2015
Source: By the author according to "Umgebungslärmkartierung Brandenburg 2012"

Since airport noise is the main reason for local residents to protest against the incoming BER Airport, a sufficient noise compensation policy should be considered as one of the most important preconditions to ensure a successful co-development of BER Airport and its surrounding urban region. Like other case study airports, a noise compensation plan[191] was made by the BER Airport operator in 2009 to protect local residents against airport noise. The noise protection area is classified as "Take-Over Area", where the most serious aircraft noise is suffered, and local residents will be resettled by airport operators; "Protected Outdoor Living Area", which includes an area of 50 km^2 and about 10,000 properties; "Day Protection Area" and "Night Protection Area", with a total area of 137,7 km^2 and a number of 25,500 residential units (14,000 residential units in both day and night protection areas, 11,500 residential units in the night protection area). Moreover, 42,000 residents in these 25,500 residential units are entitled to implement/claim for protection measures. These measures will be carried out not only for establishments that are particularly worthy of protection, such as kindergartens, schools and nursing homes, but also for residential buildings. The noise protection program ensures an indoor maximal level of 55 dB (A) by replacement of noise-isolating windows, doors and roof materials. It will also include installation of ventilation equipment in bedrooms to ensure air quality in a closed indoor space.

The ground traffic network of BER to the vicinity will also produce more noise after the BER Airport starts operating due to increased airport passenger and cargo transportation.

[191] Karin Ludwig, *Schallschutzprogramm BBI - Aktueller Stand der Umsetzung und nächste Schritte* (Berliner Flughafen, November 2010).

Therefore, when considering the BER Airport noise impact, one cannot only take noise from aircrafts into account, but should also consider the noise from increased ground traffic flows. In some places, the noise impact from ground traffic may be more serious than noise from aircraft. Therefore, noise-sensitive buildings should also be seriously considered in noise compensation programs and land-use planning.

5.5 Evaluation of the Urban Development Purpose of the BER Airport Region

5.5.1 Evaluation of the Status Quo of BER Neighboring Communities

The incoming BER Airport could be considered as an opportunity for surrounding communities to reshape their social and economic structures, adjusting to land use distribution to promote their revitalization. Therefore, a clear understanding of characteristics of each community in the BER Airport region is a significant precondition for making development plan for these communities.

Community	Positive Impacts/Stands					Negative Impacts/Stands		
	A	B	C	D	E	F	G	H
Blankenfelde-Mahlow								
Eichwalde								
Gosen-Neu Zittau								
Grossbeeren								
Koenigs-Wusterhausen								
Ludwigsfelde								
Mittenwalde								
Rangsdorf								
Schoenefeld								
Schulzendorf								
Wildau								
Zeuthen								

High Potential High-Middle Potential Middle Potential Low Potential

A: available land for residential land use; B: available land for commercial/industrial land use; C: accessibility to road/railway network; D: industrial foundation; E: tourist attractiveness and leisure; F: proportion of elderly people; G: ground traffic noise impact; H: airport noise impact.

Table 5-4: Evaluation of Status Quo and Airport Impact on Communities in the BER Airport Region
Source: By the author according to "Economic Evaluation of the Berlin Brandenburg Airport Impact on Surrounding Communities"

The above chart is a summary of the status quo and BER Airport impacts on its surrounding communities. The darker color stands for higher level of status or impacts, and the lighter color for lower levels. From the table, one can see that the status and incoming airport impacts between each community are quite different. For example, compared to other communities in BER Airport region, the availability of land use for residential and commercial purposes in Blankenfelde-Mahlow is the highest. Furthermore, numerous large firms are also settled in the community, such as the Rolls-Royce Mechanical Test Operation Center GmbH. The community also has the most superior traffic network, with not only the regional express Berlin-Potsdam and airport express BER-Berlin passing through, but also the joint of highway A10 and state road B96. It is also the host community of regular events, like the Berlin Airshow ILA. Moreover, it also has predominantly natural landscape and leisure facilities hosting tourists. However, this community has a larger population compared to other communities in the BER Airport region and suffers the most serious airport and road noise impacts. It is located directly next to the west border of BER Airport, and almost all communities are covered by the day-protection area of the BER Airport, which means residents will suffer more than 60 dB(A) of noise. Hence, this community should be considered as a focus of contradiction, and the development strategy should not only consider the economic development, but also promote living quality for local residents by noise protection programs and creation of service facilities considered as a whole. Taking the community of Grossbeeren as another example, this locality houses the Logistic Center of South Berlin (GVZ Berlin Süd), the largest logistic center in the city. It is also located next to the industrial cluster Ludwigsfelde. Airport impact on this community is not as serious as in Blankenfelde-Mahlow. Owing to a convenient logistic transportation system and the airport, the community has great potential to develop diverse airport-related or time-base industries. Thanks to less noise impact, the community could also attract more inhabitants to settle in it, thus promoting its urbanization level. Therefore, the result of the above evaluation chart could be considered as an important precondition for making development strategy and planning in both regional and community level.

5.5.2 Integrated Urban Development Purposes for the BER Airport Region

At regional level, a SWOT Analysis was also made to identify the strengths, weaknesses, opportunities and threats of the BER Airport region, as precondition for making regional development plan.

STRENGTHS	WEAKNESSES
• Superior Access to Airport; Superior Ground Traffic System; • Gateway of Berlin-Brandenburg Region, • Geographical Middle Point of Europe, Superior Place for Logistics and Cargo Transportation; • Existing Aerospace Industrial System; Cluster of Large Firms; • Affordable Land Price and Large Area of Available Land • Place of Regular Events, e.g. ILA • Superior Natural Landscape	• Noise Impact from Airport • Noise Impact from Ground Traffic • Imbalanced Industrial / Business and Commercial Development between Communities; Some Communities Lack a Polar Industry. • Drastic Civil Protest Against Airport • Air-Pollution and Ecological Risks; • Insufficient Noise Protection Measurements
OPPORTUNITIES	**THREATS**
• More Job Opportunities • Population Growth and Improvement of Social Structure • Enhancement of Existing Polar Industries (Aerospace Industries, Regular Events, Logistics, etc.) • Establishing New Polar Industries and Attracting International Firms • Rebuilding the Urban Character and Urban Image • Improvement of the Urbanization Process (Improving Service Facilities, Sustainability, Lifestyle)	• More Evident Airport Noise • More Evident Ground Traffic Noise • Ground Traffic Congestions • More Serious Ecological Risks and Pollution • Destruction of Local Heritage / Urban Image and Life Style; Population Decrease • Decision-Making Failure Causes Widening Gap Between Communities; Inefficient Investment of Public Funds

Table 5-5: SWOT Analysis of BER Airport Region
Source: By the author

According to the above SWOT analysis, the airport operator, regional/ local authorities and local residents act as behavior/interest subjects in a new airport development project. Their purposes or demands in some way are the same, but in other ways are different. Therefore, a compound and integrated airport development strategy should consider the interests of these three parts. As for airport operators, a well-developed airport appeals to the maximal economic benefits and reputation via well-organized social programs by a perfect operation process of the airport. As for local/regional authorities, on one hand they need to maximally decrease the negative impacts and thus create a livable community, but on the other hand, they need to chase developmental opportunities, to promote revitalization. For local residents, on one hand the airport should not decrease their living quality, but on the other they should enjoy the social benefits from the airports and more job and education/training opportunities.

According to the above SWOT analysis, purposes of communities in BER Airport Region could be concluded as follows:

1. Sufficient noise protection support should be provided to residents, to prevent aircraft and ground traffic noise impacts on them. It is the most important determinant to maintain livability in the airport region, to thus decrease social protests by local residents and attract new inhabitants into such regions.
2. Utilizing the airport preponderance to enhance and promote existing aerospace industry in airport regions, to hence establish a clear urban branding in airport regions.
3. Utilizing the airport preponderance to attract or enhance diversified airport-related or locally characteristic industries such as tourism, hospitality, retail, creativity, ICT, pharmaceuticals, etc.
4. Taking the airport as a chance to restructure and coordinate regional industrial distribution, closing the gap between communities through establishing new polar industries and an urban character in deurbanized communities, this way promoting the whole regional competitiveness.
5. Avoiding ground traffic congestion by controlling development intensity.
6. An integral development plan should consider the surrounding ecology/nature-preservation, to a certain extent limiting the urban expansion.
7. Local heritage should be integrated in establishing a new urban image, to thus maintain the reputation and lifestyle of local residents and also promote the local character and attractiveness.

8. A development plan should regard economic development, living quality, environmental protection comprehensively, rather than separately. The purpose of the development should not only be to build a model airport region, but also a model region that considers economic development, living quality and environment development as a whole.

5.5.3 Considerations in the BER Airport Regional Planning

Unlike the development process in other urban regions, advancements in airport regions are more instantaneous and suffer higher risks. Such regions face not only great direct impacts from the airport, but also indirect ones from ground traffic access and airport-related land use changes. Such impacts bring not only developmental opportunities, but also obvious negative impacts to such regions. Therefore, decision makers concerning airport region developments should consider the urban development planning more cautiously and comprehensively.

According to analysis of the development process of European case study airports, combined with the status of the BER airport region, various key factors should be considered by decision makers or planners, as follows:

- **Timeliness**

When a newly expanded airport starts operating, a large amount of social, public and private funds forthwith flows into the airport region, thus changing the economic structure and land use within a short time period of time. Large number of inhabitants and passengers as well as noise from airport and ground access also drastically impacts the life style of local residents. Hence, compound plans at both regional and community level which are based on the estimation of airport impacts and the status quo of the airport region are urgently needed before the new airport starts its operations, in order to avoid superfluous investment of public funds and to make proper land use politics for regional industrial and commercial land use, as well as to promote living quality and decrease negative airport impacts on residents.

- **Phasic**

Although the urban development process in airport regions is more rapid compared to other urban areas, the transformation of communities surrounding a newly opened airport could not be possibly completed in a single phase. Instead, a typical airport region will be formed over a long time period, by implementation of different development phases.

An airport regional development demands a large amount of investments of public funds on social facilities and infrastructure. Such voluminous funds cannot be invested all at once before the airport starts operating and getting any benefit from it. The land use should also be gradually planned according to specific demands, in different periods, to form an airport region step by step instead of upon planning the whole in a same phase. Hence, the development plan should be divided into different phases, and in each phase the purpose of the plan should meet the specific demands at the time, thus providing the most efficient planning for local redevelopment.

- **Coordination**

Planning for airport-adjacent communities should consider the airport region as a whole, and coordination of each community's development in the airport region plays a significant role in the plan for the area. Before an airport starts operating, the development level of each community in the airport region is very unlikely to be the same. Some communities have a superior basis of industrial and business development, and thus greater potential to become the new urban development hot spots in the region. There are also some communities that lack polar industries or urgently need industrial restructure. Such localities could use the airport as an activator to establish their new polar industries, and so revitalize the urban development in these communities.

Airports have a better basis and climate for investments. However, as a regional planning that considers all communities in the airport region as a whole, it should not only regard how to develop communities with better basis as new hot spots, but also consider how to use the airport as an opportunity to revitalize communities by their geographical advantages, thus narrowing the gap between each community and creating a balanced development and coordinated airport region.

Because in the practice each influencing factor does not separately impact the region, all these factors should be considered coordinately into a single plan already at the urban planning and design level. For example, noise protection measures could be integrated within energy efficiency. Noise protection for traffic corridors could also be integrated with urban branding in urban planning, to protect against noise impact on local residents as well as to create new commercial corridors along traffic accesses to provide highly efficient business land use for regional economic progress.

- **Flexibility**

Commonly, the regional planning for the airport region follows the top-bottom direction,

and mainly considers the whole region's development as its main content. Regional planning cannot contain more detailed aspects of the community level; this way, such planning does not sufficiently serve as a guide for communities for their further development. For each airport-surrounding community, regional planning could only indicate the development directions, but not a more detailed community planning based on the status of each community. Therefore, it is very significant to guarantee a certain degree of flexibility for communities in the airport region, to let those go further steps in their planning under certain conditions.

Urban development is a continuous process, but not immutable. Because the impact of an airport region on urban development is more complex and more drastic, the development in this area is more dynamic. For example, airport capacity and airport noise contour will directly impact the local land use planning, and the airport capacity changes annually. Taking ground traffic as another example, when an access to the airport is connected, the land use and spatial pattern should also be changed according to the impacts of the new airport access. The status and process of urban development will also impact the further progress of such communities. Hence, land use planning should be timely adjusted according to the changes in the airport capacity, and should be more flexible and timely, leaving certain potential according to the demand of frequent impact changes.

- **Public Participation**

Public participation and civic engagement play an increasingly important role in urban design and planning. According to D. Slocombe[192], "Opening the opportunity to embrace cultural and social diversity that characterizes the population of the cities today, the development of an operative planning process also implies the inclusion of public participation as active factor in the process of sustainable development". When considering the importance of public participations, "The effective participation of both population and local administration during the entire process is a major factor for its efficiency, since increasing the partaking of the intervening actors prevents the occurrence of potential conflicts, guaranteeing a faster acceptance of the new ideas for urban structure"[193].

For airport regions, public participation is even more significant in the planning process.

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[192] D. Scott Slocombe, "Environmental Planning, Ecosystem Science, and Ecosystem Approaches for Integrating Environment and Development," *Environmental Management* 17, no. 3 (May 1, 1993): 289–303

[193] M. P. Amado et al., "Public Participation in Sustainable Urban Planning," *International Journal of Human and Social Sciences* 5, no. 2 (2010): 102–8.

First, urban design and planning are commonly difficult to be accepted by the public. When an airport starts operating, it leads to a rapid change of urban spatial formation. Such urban transformations will change the original urban image and the urban identity of airport-adjacent communities. Therefore, the sense of belonging of residents of these communities will be more or less interrupted, thus generating public protests against the implementation of the new planning process. However, when public participation is considered in the formulation phase of the planning, and the initiative of residents is respected, the planning is more easily accepted by the public, which relieves the pressure in implementation of the planning.

Second, history, culture, heritage and life style together form the urban identity and rationality, which are important elements of "soft power" in the future urban development. Traditional urban context is also an important element for continuation of the urban context in the development process. It has been proved by many airport region development cases that a large-scale civil infrastructure, such as an airport, will drastically change the urban identity of the whole region. However, well-operated public participation and integration of civil engagement in the planning process is an efficient tool to avoid the disruption of urban identity and urban context in the planning process.

5.6 **Conclusive Summary**

In this chapter, the author took the BER airport as the test bed, integrated the research findings of previous studies and the status of BER airport region, to evaluate on the BER airport impact on its surrounding communities, and tries to investigate on the development purpose or principals of the future BER airport region development.

First of all, based on selected literatures and statistical data, a brief introduction of the redevelopment of the BER airport and its associated real estates has been made as a preliminary study of BER airport impact on its surrounding urban region.

Second, in accordance with established models proofed in chapter 2, a regression analysis of the BER airport impact on the variation of the future population density and the percentage of elderly people has been made. From this analysis, according rising annual airport passenger, the increase of population density and decrease of elderly people has been estimated (e.g. if the amount of BER airport passengers grows from the starting 27 million to 30 million, the population density of the BER Airport region will grow to 313 people/km^2. If the number of BER airport passenger grows to 35 million, the population

density of the BER Airport region will grow to 355 people /km^2.) Meanwhile, the decrease of elderly people in BER airport region according to increase of BER annual passenger is also been estimated. (E.g. After the airport starts operating, the proportion of elderly people in the airport region will decrease from 20.9% to 18.05%. If the annual passenger number of the BER airport reaches 30 million, the proportion of elderly people in its surrounding region will decrease to 17.87 %.)

Third, according to the previous studies of airport impact factors and their influences on land use distribution, an evaluation study of the land use variation has also been made, which could be used as reference of the future land use planning in BER airport region.

In this study, based on the current land use distribution status, an evaluation of the economic activity and competitiveness of each community, traffic networks as well as available land for further urban development in BER airport region has been made, as the precondition of the prediction of future land use development of each community in the BER airport region.

One step further, a density analysis of commercial, residential, industrial, educational and sport and leisure land use in BER airport region has been made. The land use distribution and cluster features could be clearly seen from the resultant of the BER airport region. According to the density analysis, in accordance with ground traffic networks and the previous study of land use distribution features in each case study airports, the opportunities of each land use in each community in BER airport region has been evaluated. Meanwhile, according to literature study and the resultants of density analysis, characteristic industries in BER airport region has been evaluated, which is not only significant as a precondition for further regional economic development, but also plays an important role in enhancing the locality and urban identities in communities of BER airport region.

The land use study also includes the comparison study of distribution features in different scopes of eight case study airports and BER airports, in order to find out the development level of each land use in BER airport region compare with common level of European international airport region. From the study resultants, it could be seen clearly that even the new BER airport still not start to operate, but airport-related industries have already been formed in the BER airport region. The proportion of commercial and the industry land use in BER airport region is even higher than predicted volume by established regression model. It indicates that the BER airport region will has a good foundation for future airport-related industrial and commercial development. Meanwhile, the study also

indicates several problems that may hinder the further urban development, such as unbalanced economic development and land use distribution in BER airport region.

The study also includes the hotspot analysis of industrial and commercial land use distribution in BER airport region. Based on the analysis of the hotspot analysis of current industrial and commercial land use distribution, the cluster tendency has been evaluated. Combine with the resultant of the hotspot analysis and the current traffic, economic and demographic status etc., the prediction of future expansion of current industrial and commercial hotpots, as well as new hotspots and corridors has been predicted in the BER airport region.

Forth, according to studies of airport influence to airport region, the current status of BER airport region, an evaluation study has been made to evaluate the urban development opportunities and potentials in the BER airport region. A SWOT analysis has also been made to define the future strength, weakness, opportunities and treats in the BER airport region. In accordance with the SWOT analysis, the urban development purposes and principals of making urban development strategies in BER airport region is also been indicated.

6 Research Programs and Pilot Projects in Establishing Berlin Brandenburg Airport Region

After the planning approval to expand the BER Airport, many research programs and pilot projects have been launched for dealing with airport impacts on regional and community level. These research programs and projects include diverse participants such as states, districts and community authorities, the BER airport operator, research institutions, universities and urban development companies, as well as local residents' representatives, to thus create comprehensive development strategies for the BER airport region.

6.1 Dialog Forum and Structure Plan on Regional Level

■ Background and Structure of the Dialog Forum

The BER project provides economic growth for the region, on the one hand by opening up a wide range of future prospects for the local residents and the surrounding communities, while on the other by, after closure of the Tegel airport, becoming the one and only commercial airport in Berlin-Brandenburg. This means a new strain for residents in the south of Berlin and Brandenburg.

Therefore, to face challenges and opportunities, the dialog forum was established in 2006 in order to provide a platform for diverse interest parts to communicate and make integrated strategies. Participants of the dialog forum are from diverse parties and levels that include[194]: Senate Department for Urban Development of Berlin and Ministry of Infrastructure and Agriculture Economy of Brandenburg, at state level; municipality authority of Dahme-Spreewald, Oder-Spree and Teltow-Flaeming, from Brandenburg, and district authorities of Neukoelln, Tempelhof-Schoeneberg and Treptow-Koepenick, from Berlin, at county/district level; 12 community authorities from Brandenburg at community level; and the Berlin Airport Group as well as related municipal bodies also involved, as an independent party.

The dialog forum includes three working groups, such as the "Balance of Interests", "Airport Noise" and "Community and Inter-Community Development" groups. The

[194] www.Dialogforum-ber.de

purposes of the dialog forum are[195]:

01. To promote a fair, transparent and intensive dialogue between members at different levels and interests; the solution of conflicts between members on a voluntary basis, and under consideration of all interests.
02. To enable joint arrangements with the purpose of balancing the interests for the development of the airport region.
03. To deal with a balance of interests, aircraft noise and noise protection, as well as community development, and to investigate on compromising solutions.
04. To provide guidance and support in the implementation of the joint development conceptual planning of the airport region (GSK FU BBI).

Based on joint regional planning of Berlin-Brandenburg, the dialog forum has worked for two years and promulgated the "Joint Conceptual Structure Plan of the BER Airport Region (GSK FU BBI)": The atlas provides a foundation, which grants planning security for communities and investors, and clearly indicates opportunities and challenges of the whole region.

As of 2009, the Dialogue Forum should be the main responsible for the development of the airport region. It should be financed by the Berlin Airport Group and managed by an external moderator. The dialog forum was planned to take place twice a year to balance the interests of diverse parts, and implement and evaluate noise/sound protection and regional resolutions.

- **Joint Conceptual Structure Plan of BER Airport Region (GSK FU BBI)**

To ensure that the demands that the BER Airport will be facing are met, the "Joint Structural Concept for the Area surrounding BER Airport" was developed as construction are underway. In order to build consensus during the planning process, and to have all stakeholders enter a dialog with each other, the Joint Spatial Planning Department brought all administrations of the municipalities, cities and states together, as well as the administrative districts, the regional planning authorities and the Berlin Schoenefeld Airport Company, giving them the opportunity to state their respective needs and interests. A jointly developed guiding principle sets out the basic tenets of what was agreed upon for the future development of the airport environment. The area surrounding the airport is exceptionally suitable for distinguishing the BBI Airport among its international

[195] www.Dialogforum-ber.de

competitors. The Mutual Structural Concept has created the framework within which the airport region will develop in economic terms, and will ensure the cooperation of all stakeholders in the long term[196].

According to the urban development status of the Berlin-Brandenburg metropolitan region, the BER airport region and the predicted airport impact, the joint development plan (GSK FU BBI) first investigates a coordinated conceptual plan. The structural concept enables municipalities to pursue residential developments and to create commercial areas. This way, they can enhance their profile, and thus their opportunities for economic development[197].

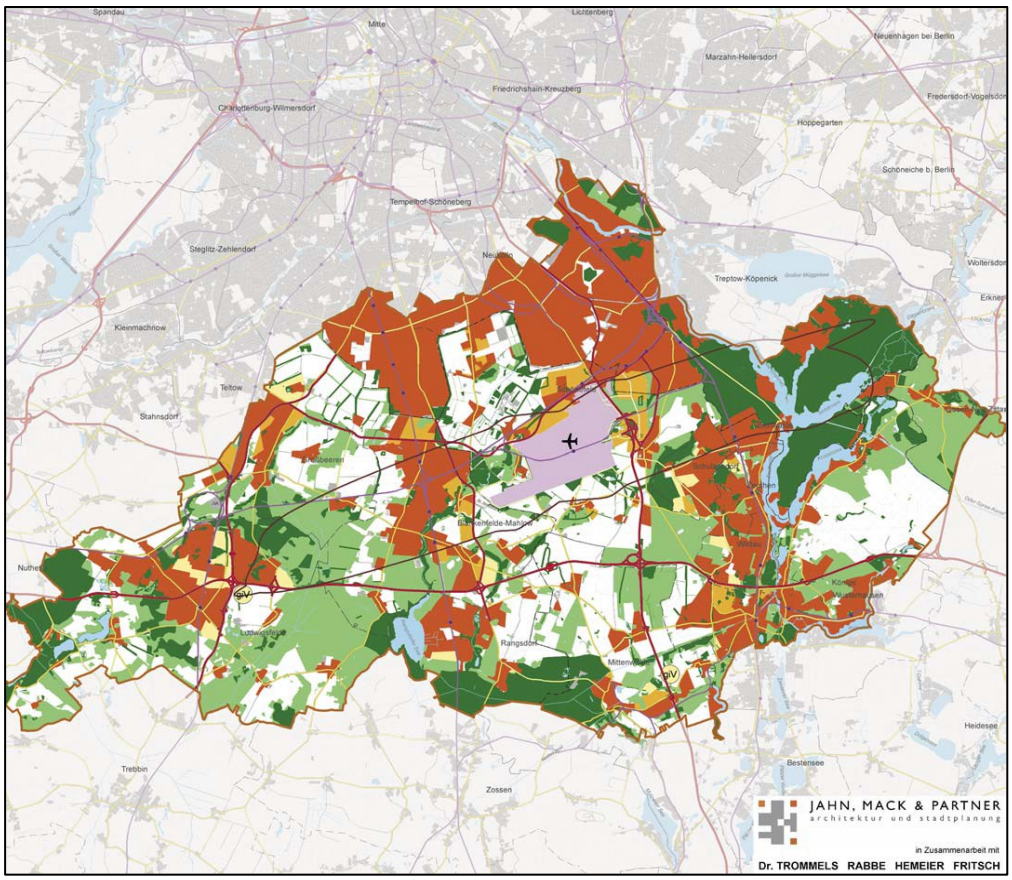

Figure 6-1 Joint Structural Concept for the Area Surrounding the BBI Airport
Source: Gemeinsames Strukturkonzept Flughafenumfeld Berlin Brandenburg Internation (in German)

The structural concept plan also includes a traffic network upgrading according to the

[196] *Gemeinsames Strukturkonzept Flughafenumfeld Berlin Brandenburg Internation* (in German), Ministerium für Infrastruktur und Raumordnung Brandenburg, April 2007

[197] *Gemeinsames Strukturkonzept Flughafenumfeld Berlin Brandenburg Internation* (in German), Ministerium für Infrastruktur und Raumordnung Brandenburg, April 2007

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opening of the airport. When the airport starts to operate, the highway will connect the airport to Berlin's city center and to the Schoenefelder Kreuz Autobahn intersection. A four-lane expressway will connect the terminal building with the Autobahn. The 96a regional expressway to Potsdam and the B96 road connecting Rangsdorf to Berlin will both become four-lane expressways. The Deutsche Bahn will integrate the BBI Airport as a stop in its railway system, providing connections on a regional, national and international scale, above all to Poland and the Czech Republic. The tracks to BBI Airport are designed to accommodate the high-speed ICE trains. An airport shuttle will bring passengers to the center of Berlin in about 20 minutes. Numerous S-Bahn and bus connections will supplement the range of options[198].

The area surrounding the BBI Airport has approximately 900 hectares of land reserved for potential development as commercial/industrial sites. In addition, the Structural Concept has defined a further 1,330 hectares as potential commercial/industrial areas. In the period from 2009 until 2019, approximately 250 hectares of land will most likely be needed to cover the demand for new settlements that will be generated by the airport. This corresponds to 25 hectares per year. Until 2035, up to 800 hectares will probably be needed for such purposes. New settlements will be concentrated in specific locations. These will mostly be in the direct vicinity of the airport and along the traffic axes from the airport into the center of Berlin, and will also include sites where the existing businesses have already created a positive locational profile. Further sites will be needed for expansion and settlements that are independent of the airport.

In the airport region, approximately 450 hectares of land are reserved for residential development. These have been zoned under the planning law. The Structural Concept has established that another 780 hectares of land may also be developed for residential usage. Based on experience gained in other airports, it should be expected that the demand for residential units will increase steeply as soon as companies move into the area. What will be important for any residential units built is that public transportation, daycare facilities and schools be available, and that a wide range of cultural opportunities as well as the possibility to pursue recreational activities are given in the immediate vicinity[199]. It is only

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[198] *Gemeinsames Strukturkonzept Flughafenumfeld Berlin Brandenburg Internation* (in German), Ministerium für Infrastruktur und Raumordnung Brandenburg, April 2007

[199] *Gemeinsames Strukturkonzept Flughafenumfeld Berlin Brandenburg Internation* (in German), Ministerium für Infrastruktur und Raumordnung Brandenburg, April 2007

in the planning zone limiting settlements that no residential units or any establishments requiring a higher degree of protection against noise may be built. It is permissible to give existing residential areas a higher density if this can be approved pursuant to Section 34 of the German Building Code[200].

The Structural Concept Plan also includes a nature, agriculture and landscape reservation plan. The open space between the settlement axes will be connected with each other on a larger scale, in order to conserve valuable biotopes for animals and plants, while the interconnecting recreations will attract visitors. Agricultural areas are an important component of the cultural and recreational landscape. Not only will they be conserved, but will even be enhanced, since they ensure that the ground water can regenerate and that the air is cooled.

Except for the above regional level part, the structural concept plan has also included the evaluation and conceptual plan at community level. Several regional development poles have been indicated, such as the "Schoenerfelder Kreuz", which is a development belt/area located at the intersection of the communities of Wildau, Schoenefeld and Koenigs-Wusterhausen. The plan at community level also indicated the development tendency and outlined the urban profile of these communities. For example, the localities of Eichwalde, Schulzendorf and Zeuthen are so-called "garden towns", being connected to Berlin via S-Bahn and full of superior natural landscapes like waterways, lakes, grassland and forests, which makes the residential settlements to be more like vacation resorts. Therefore, the structural concept plan has defined these three communities for large residential properties. Ludwigsfelde houses numerous "light-house companies". The location of this community has also good railway and road connections. Therefore, Ludwigsfelde is indicated as an exceptional site for technology, and is one of the most successful regional growth poles in Brandenburg. Grossbeeren has excellent location and good traffic connection make it to the freight distribution center, and one of the most important reloading facilities in the capital region. Blankenfelde-Mahlow is the most populous municipality in the administrative district. However, the construction of the BER airport will restrict the community's future as a residential location. Therefore, the community will head on a successful commercial location. Rangsdorf plays a role as an important logistic location as well as a popular destination for recreational activities.

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[200] *Gemeinsames Strukturkonzept Flughafenumfeld Berlin Brandenburg Internation* (in German), Ministerium für Infrastruktur und Raumordnung Brandenburg, April 2007

One important component of the conceptual plan is to balance out the advantages and disadvantages that the airport entails for the municipalities in the region, and to do so as fairly as possible.

6.2 **Planning at Community Level**

As the "Joint Conceptual Structure Plan of the BER Airport Region (GSK FU BBI)" has indicated the future land use structure and network development, as well as the assessment of each community in the airport region, these communities should evaluate their status and investigate their strategies and development plans based on the regional plan, its status and the future challenges and opportunities that the BER Airport shall bring.

Let us take Blankenfelde-Mahlow as an example. This community is situated to the west of the new BER airport, and in the direction of the airport starts/landings. Moreover, Blankenfelde-Mahlow is also the most populous community in the administrative district Teltow-Flaeming. Therefore, the noise from the new airport will by all means impact the life quality of the community. The airport will also restrict the community's future as a residential location.

However, the community has a superior traffic connection and is the intersection of the highway Berliner Ring A10 and the state road B96. The railway Berlin-Dresden and the airport expressways Berlin-BER and Potsdam-BER also cross the geographical center of the community. Therefore, the airport, combined with the advanced ground connections, makes the community a potential development hot spot for commercial, logistic and industrial development. One example for this is that the Rolls-Royce Engine Test Center is already established here because of the convenient connection to the airport, which could be a development foundation for commercial/industrial developments.

As the community of Blankenfelde-Mahlow is the intersection of both positive and negative impacts from the airport, for drawing future development strategies the community's authority is initially engaged in investigating comprehensive solutions and plans.

- **Joint Winter School "Soft Soundscape Community " TU-Berlin**

The joint winter school "Soft Soundscape Community – Strategies for the Model Community Blankenfelde-Mahlow" was a German-China joint student workshop taking place from 9 to 22 January 2011 with three universities (Berlin University of Technology as the host university, and Tsinghua University and Beijing University of Architecture as

guests). The organizer of the workshop was Prof. Klaus Zillich, Chair of Sustainable Urban Development of the Institute of Architecture, Planning and Environment at the Berlin University of Technology; the project was financed by the German Academic Exchange Service (DAAD). During the 13 workshop days, 30 students (15 from the TU-Berlin and 15 from Chinese universities) were divided into six working groups to investigate urban development strategies for the community of Blankenfelde-Mahlow, aiming to re-urbanize the locality as a "better living community within important mobility corridors". The author of the dissertation at hand was also a teaching tutor in the joint workshop.

The final presentation of the workshop took place on 22 January 2011 to show the results to the joint teaching committee composed by professors from these three universities, as well as representatives from the new BER airport and from the community of Blankenfelde-Mahlow.

Figure 6-2 Vision of Sound Sculpture as Illumination System in Blankenfelde-Mahlow
Source: Student Work of Winter School "Soft Soundscape", Students: Ouyang Wenjie, Björn Wittik

■ Land Use Plan for the Community of Blankenfelde-Mahlow

In 2011, the community authority entrusted the planning office LANDPLAN GmbH with presenting the latest "Land Use Plan for the Community Blankenfelde-Mahlow". The "Plan" is a reaction of local communities to existing settlement pressure on residential and commercial land uses, and also addresses the specific conditions of the BBI Airport.

The planning horizon of the land use plan covers a period of 10 to 15 years. The presently estimated final year of the plan is 2020.

The main contents of the plan include[201]:

1. Preliminary study – implementing development plans under legal binding;
2. Urban development study – comprehensive land use concept and purpose;
3. Study of foreseeable demands – implementation and feasibility;
4. Internal specifications – representations are like a coarse grid detailed planning with some deviations (commitment under the development increment);
5. External effect – strategy for external Impacts

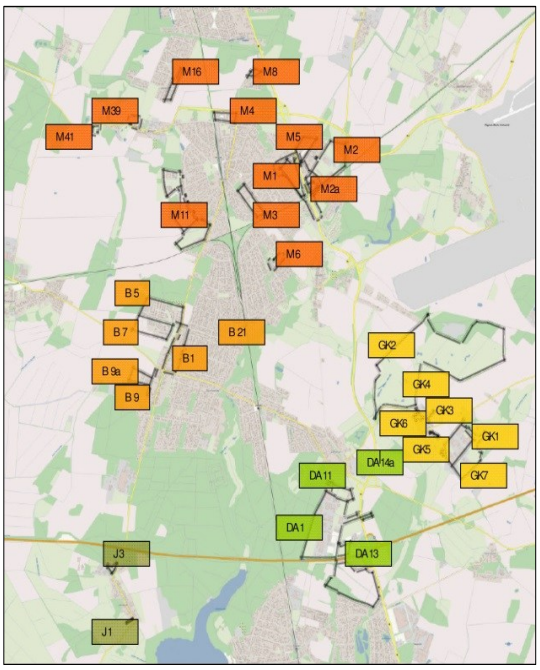

Figure 6-3 New Developments in the Community of Blankenfelde-Mahlow
Source: Flächennutzungsplan für die Gemeinde Blankenfelde-Mahlow

Figure 6-4 Height Limit in Blankenfelde-Mahlow
Source: Flächennutzungsplan für die Gemeinde Blankenfelde-Mahlow

The land use plan is in accordance with the foreseeable needs of the community. In addition to information regarding the future land use structure of the community with regards to open spaces in the municipal area, such as green spaces, water or agricultural areas, it also includes statements about facilities and claims to substantial space uses in the community, such as transport or goods logistics, and information on the equipment of the municipal area with facilities and apparatus of public and private services (community halls, fire brigades, etc.) and statements on usage restrictions and regulations for reasons of environmental protection and protection against contamination.

[201] Dr. Schuschke, Flächennutzungsplan für die Gemeinde Blankenfelde-Mahlow, Landplan GmbH, access on September 2011, http://geoportal.teltow-flaeming.de/de/daten-und-dienste/Kommunen/41-blankenfelde-mahlow.php

6.3 fAIR Leben Project

■ Occasion

The community of Blankenfelde-Mahlow is not only the most populous in the airport region, but is also located in the geographical intersections of two important trans-European mobility corridors: The new ICE lane Northern Europe-Berlin-Dresden, and the southern part of the highway Berliner Ring A10, which is the middle-point of the Paris-Moscow highway corridor. Therefore, the airport and the superior ground traffic connections provide great dynamics for urban development. The community, however, had expected potential spatial growth and economic impulses to be affected by the airport. With the establishment of Rolls-Royce Engine Test Center and the regular event of the Berlin Air Show (ILA), the community has become a national attractor of aerospace industry.

■ Themes

The "fAIR Leben" project, a kind of communal future research group with public and private actors, is divided into four different themes[202]:

1. Establishment and operation of the network of stakeholders from research, science, business, politics, administration and the citizenry: During the project, two large network meeting of all parties are planned. Regular meetings will also be planned in theme-related working groups.
2. Development and implementation of exemplary measures to reduce noise pollution in indoor and outdoor space: Options provided for the implementation of an effective sound insulation, which goes beyond the extent required by law, are to be compiled in a catalog and a manual. Pilot projects, for example in a noise-sensitive public facility such as a daycare center, shall be implemented at the exemplary site.
3. Health Promotion: Focus on noise impact on health and life quality of local residents. To provide recommendations for local residents in avoiding noise impact on their health and life quality in their residential units, as well as to investigate practical measures to reduce noise impacts on noise-sensitive facilities and open spaces in the BER airport region.

[202] Der Flughafen als Nachbar: Land Unterstützt Zukunftsprojekt “Fairleben“ in Blankenfelde-Mahlow mit fast einer Million Euro, accessed on 13.03.2010, www.mil.brandenburg.de

4. Establishment of trust and credibility through transparency and reliability in the airport region, and provision of the basis for a future-oriented development identity: A transparent and trusting communication with understandable information materials and the appropriate involvement of all public and private actors in solution-finding and decision-making processes within the "fAIR Leben" initiative, from the beginning and also through the project period. Among other things, an Internet platform, a guide of participation process, and an approach to strengthening the civic identity formation are in planning.

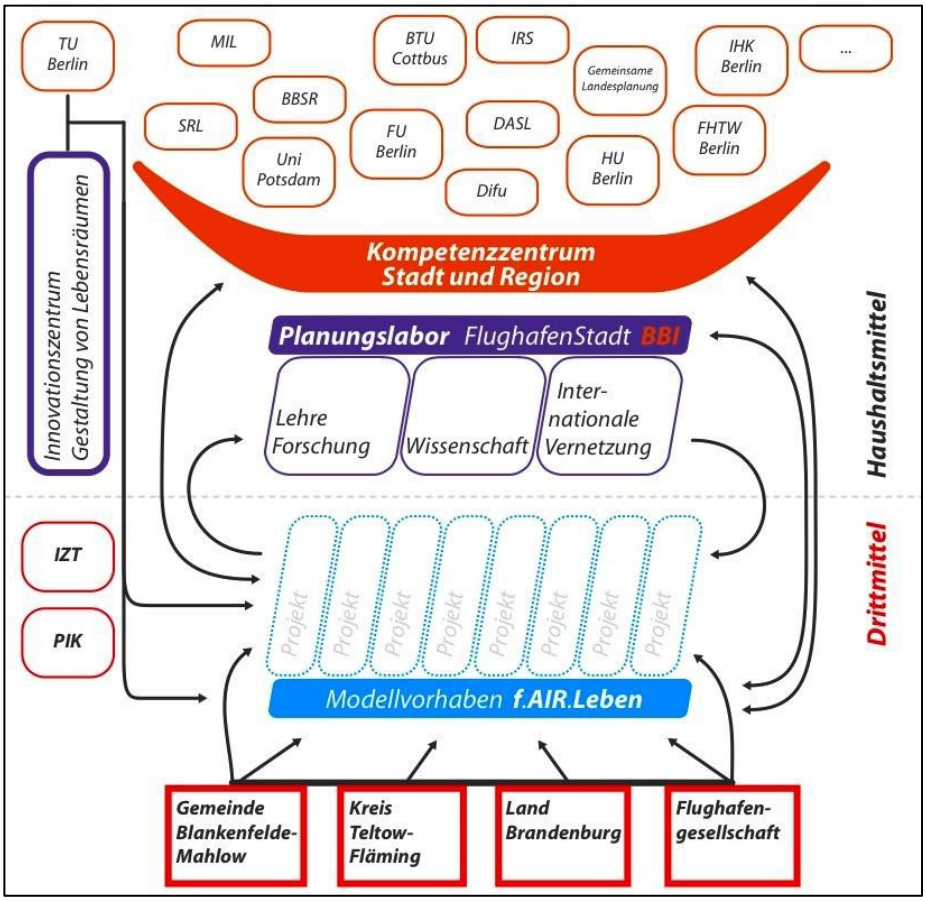

Figure 6-5 Organizational Structure of Project "fAIR Leben"

Source: Modelvorhaben fAIR Leben Lebenen fAIR Lebene

■ Purpose

The research purposes of the model project are[203]: to take the model community Blankenfelde-Mahlow as a test field for noise acceptability and sustainable urban revitalization adjacent to an airport; to investigate innovative and integrated solutions for

[203] Der Flughafen als Nachbar: Land Unterstützt Zukunftsprojekt "Fairleben" in Blankenfelde-Mahlow mit fast einer Million Euro, Accessed on 13,03,2010, www.mil.brandenburg.de

re-urbanizing, based on noise compatibility, energy efficiency and environmental sustainability, high living quality and good governance; as well as to search for concordant solutions that need to be promoted by citizen participation, economic development, involvement of stakeholders, exemplary implementation, close cooperation of academics and practice, global research partnership with comparable regions, as well as scientific evaluation of the process and the results and transferability of the modeled solutions.

■ **Existing Project Progress**

The project progress could be explained in three areas. First, the actual programming includes the content and organization design of the overall program with the necessary frameworks for the individual projects. Second, the financing concept identifies possible funding sources at all levels, and evaluates them. As far as possible at this point, a financial plan is created that takes into account the already acquired budgets. Third, the project environment development includes an intensive stakeholder and commitment management. Through intensive communication and comprehensive participation this is already possible in the project development. This will ensure broad acceptance in a difficult environment.

1. Implementation of the annual meeting by the Planning Laboratory city airport BBI in Blankenfelde under the title "Robustness and flexibility. New perspectives for the BBI Airport City."
2. First meeting of representatives of the community and the county, with members of the competence center, community and region;
3. Establishment of a steering group for further development and coordination of sustainable development activities in the airport region, as well as assembly of a core team for project development;
4. Creation of a (preliminary) structure for project development with a control circuit (previous working group plus other active members), control group (core group to control the project development), Scientific Coordination Office (Planning Laboratory at Airport City BBI);
5. Presentation of the project "fAIR Leben" at the Ministry for the Environment, Health and Consumer Protection of the Federal State of Brandenburg;
6. Presentation and discussion of the project "fAIR Leben" with representatives of the State Chancellery, the Ministry for Health, Environment and Consumer Protection of the Ministry for Infrastructure and Agriculture and of common land planning Berlin Brandenburg (GL);
7. Presentation and discussion of the project "fAIR Leben" at the airport company

FBS;

8. Presentation of the project "fAIR Leben" by Mr. Baier, the major of Blankenfelde-Mahlow, in the Dialogue Forum BBI airport region;
9. Formulation of each of these objectives with concrete participation of stakeholders;
10. TU-Winter School 2011;
11. Participation in the 2nd Expert Noise Conference of Teltow-Flaeming.

Having begun at the beginning of 2012, the project will be promoted in the next three years with a total of 970,000 Euro in extra funds from the infrastructure budget of the State Brandenburg. The fact is the community intends to provide the initiative with an additional 600,000 Euro out of its own funds and attract additional external funding underlines the ambitious goal of bringing as many concrete projects on the way as possible[204].

- **Approaches for implementation**

1. New Residential Development – Corporation with Large Private Investor

Kondor Wessels, as one of the major investors in the field of housing development and owner of over 50,000 m^2 in buildings in Blankenfelde-Mahlow, has shown great interest in the project and its expressed objectives (original comment by a representative of the administrator of the real estate developer: "Exactly the kind of project we've been waiting for"[205]). In the view of the investor, the combination of concrete innovative ideas and general measures for the transformation of the community are precisely appropriate and necessary for future investments. Therefore, Kondor Wessels may also engage in the project and develop a whole new residential project with innovation of noise isolation technologies, thus to promote living quality. In addition, the investor has larger properties in the airport region (e.g. Koenigs-Wusterhausen) which are also not yet developed. Therefore, the project in Blankenfelde-Mahlow could be a technical and advertisement exemplar for further residential advancements in other communities in the airport region for this company.

Therefore, this shows that it is possible that investors could engage and gain benefits in research projects by investing in development of residential areas under the instructions and support of the research project, and could also be a model solution for similar

[204] Der Flughafen als Nachbar: Land Unterstützt Zukunftsprojekt "Fairleben" in Blankenfelde-Mahlow mit fast einer Million Euro, accessed on 13.03.2010, www.mil.brandenburg.de.

[205] Projektbeschreibung „fairleben - Nachhaltige Entwicklung einer Kommune im Umfeld eines Großinfrastruktur-projekts (Blankenfelde-Mahlow - Flughafen BBI), Authors: bsf, cz, gg, js, moh, mp, we, jf,ppl, ew, May 2011

residential projects in other communities of the airport region.

2. Noise-Sensitive Facilities and Public Space

Blankenfelde-Mahlow is a typical community with a high density of residents in the Brandenburg state. Thus, the community houses numerous kindergartens, schools, daycare and nursing homes, which are noise-sensitive social service facilities. Therefore, how to concordantly integrate such facilities in the BER airport noise buffer region is a challenging task in promoting living quality for the community. Existing architecture/urban design projects dealing with noise could be introduced into the community of Blankenfelde-Mahlow to reduce airport noise impacts on local residents.

The kindergarten “Kita Lützowstrasse” in Berlin could be a good example for preventing noise impacts on children. In an architecture approach, a glassy transit space used as children play space in-between the indoor and outdoor space was built, which could well protect children from traffic noise impacts outside. Moreover, the glassy transit space as play-space could also protect local residential units against noise from children. Similar such solutions are discussed on both conceptual and practical levels in the Blankenfelde-Mahlow noise protection program for decreasing airport noise impacts on noise-sensitive facilities.

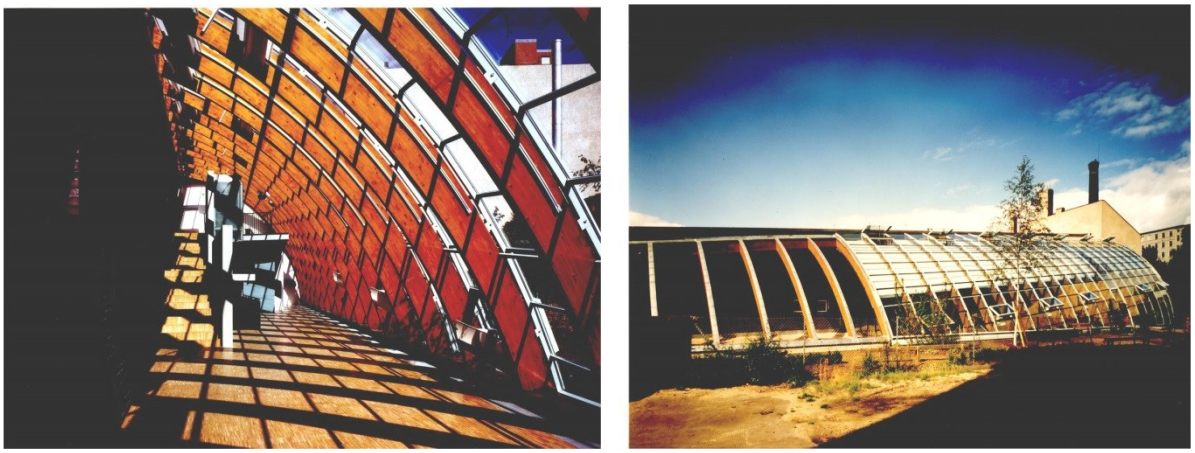

Figure 6-6 Kita Lützowstr. Berlin, Design by Halfmann and Zillich
Source: Soft Sound Climate Envelopes, Cooperation Climate KIC/ TU-Berlin & Joint Research Project fAIT Leben

The project “Urban Square Nauener Platz in Berlin” could also be a model project to be introduced to the community of Blankenfelde-Mahlow. The Urban Square Nauener Platz in Berlin has been recently remodeled and reconstructed by urban planners and acousticians in order to improve its ambiance – with special regard to its sonic properties. One of the outcomes of this project is a middle-sized noise barrier (gabion wall) reducing the

crossroads' traffic noise on the playground by 3 dB[206].

Following a distinct 'soundscape approach', acoustician Prof. Dr. Brigitte Schulte-Fortkamp and her colleagues at the Technical University of Berlin not only took measurements and calculated noise contour maps, but also conducted 'soundwalks' and invited local residents to participate in the planning process. As a consequence, several 'audio islands' were installed: today's visitors of Nauener Platz are supposed to sit down on 'ear benches' with integrated speakers to listen to ocean waves or bird singing. The sound files are intended to mask the noise from the crossroad, thus creating a pleasant listening experience for the visitors of the playground. Yet, the sounds from the ear benches rather merge with the traffic noise, thus creating a strange mix of sounds which were formerly antithetic: soothing ocean waves meets the ebb and flow of the traffic[207].

Figure 6-7 Gabion Wall as Noise Buffer in Nauener Platz
Source: By the author

Figure 6-8 Sound Device + Public Furniture in Nauener Platz
Source: By the author

Additionally, in the following field recording from Nauener Platz one can hear children letting off their last fireworks (soon after New Year's Eve), thus performing their own noisy interventions within a re-modeled soundscape. For her work at Nauener Platz, Prof. Dr. Schulte-Fortkamp was granted the European Soundscape Award in November 2012[208].

3. Climate and Noise Protection Envelopes

Winter garden, as a popular architectural approach for spatial extension of residential units, is at the same time also an efficient noise protection measure in combination with energy

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[206] Sonic Agents, "A Soundscape Remodelled," *Sonic Agents*, accessed September 29, 2014, http://sonicagents.wordpress.com/2013/01/04/a-soundscape-re-modeled/.

[207] Sonic Agents, "A Soundscape Remodelled," *Sonic Agents*, accessed September 29, 2014, http://sonicagents.wordpress.com/2013/01/04/a-soundscape-re-modeled/.

[208] Sonic Agents, "A Soundscape Remodelled," *Sonic Agents*, accessed September 29, 2014, http://sonicagents.wordpress.com/2013/01/04/a-soundscape-re-modeled/.

efficiency.

The architectural approach of climate envelopes could also be used in renovation of hospitals, nursing homes and other noise-sensitive facilities. For example, the “Pyjama Garden”, which is a building expansion project of a medical center in Veldhoven, the Netherlands, could be a good example to show a high-quality climate envelope instead of typical hospital architecture typology. Such methodology could be broadly used in Blankenfelde-Mahlow to create a high-quality transitional space, as well as to protect against noise impacts on indoor activities.

The research of Schlaich Bergermann and Partners on behalf of the Federal Ministry of Education and Research (BMBF) focuses on investigating environmentally friendly, energy-efficient, noise-proof and economic developments of industrial and commercial estates. The result of the study could also be used in industrial and commercial estates in the community of Blankenfelde-Mahlow, not only protecting from airport noise in the indoor space, but also reducing the noise impact from indoors to the outside public space.

7 Summary and Further Research Directions

7.1 Major Empirical Findings

Airports – especially large international airports – are planned as regional economic engines, providing great opportunities for urban revitalization and redevelopment of airport-adjacent regions. Such urban revitalization includes not only spatial reorganization, but also changes in the urban economic structure, demographics and land use distributions.

Meanwhile, airport impacts on adjacent communities include not only direct influences from airports, but also indirect effects from airport-related ground traffic networks and airport-related industries. The urban status of airport-adjacent communities could be seen as responses to these influencing factors.

Therefore, urban planners and administrations responsible for planning and decision making regarding airport adjacent regions should consider urban development plans to be maximally correlated with direct and indirect airport impacts. Meanwhile, the spatial planning in airport regions should also be correlated with airport burdens on demographic changes, land use distribution features, and economic structure variations. Therefore, a better understanding of airport impacts and their effects on the airport's periphery is significant as a planning precondition for decision makers.

Unlike other urban researches, which base on isolated case studies of airport repercussions on adjacent regions, this dissertation is more focused on the investigation of a series of airport case studies, so as to detect the common correlations between airport impacts and variations in the urban status resulting thereof. Based on the findings concerning airport effects and the corresponding urban status of the airport-adjacent regions, the author has also discussed the development strategies for communities bordering the new Berlin Brandenburg International Airport. The obtained key findings could be summarized as follows:

First of all, based on a large number of statistic data from eight major European international airports, and by introducing the linear regression and original least square methodology, several correlations between airport capacity and demographic and land use distribution features could be found. The airport's annual passenger number is closely correlated with the population density and the rate of senior people in the airport region. Statistics show that the higher the annual passenger number of an airport, the higher the

population density in the airport adjacent communities. On the other hand, the higher the number of annual airport passengers, the lower the rate of senior people will be in the airport region. Using linear regression resultants as basis, it is possible for local authorities and urban planners responsible for making decisions about further developments in airport regions to predict the future variations in the population density and the rate of elderly people based on annual passenger number, which would be a good foundation for further planning and creation of developmental strategies.

Second, based on a large number of statistical data and linear regression models, the correlations between airport capacity and volume of different land uses were also discovered. The annual airport cargo volume is correlated with the intensity of industrial land use. The annual passenger number, as well as airport employee number, is correlated with the volume of residential land use. The annual passenger number is also correlated with the commercial clusters within the airport region. Therefore, for local authorities and city planners, by using the linear regression outcomes it is possible to predict the total volume of different land uses in airport regions, thus allowing creating a proper land use plan in airport regions and avoiding decision making failures.

Third, based on the GIS hotspot analysis methodology, aircraft noise, noise from airport ground accesses, airport spatial relationship with the city, the status of airport ground traffic networks and their repercussion on urban spatial structure and land use distribution were studied here. Suggestions have been given as guidance for making new urban planning in airport regions.

Fourth, as urban branding and proper urban image are more and more important in the knowledge economy era, a positive urban image may bring great social and economic benefits for airport regions by attracting investments and new inhabitants, retaining residents, and promoting local visibility by attracting media attention. Therefore, a study on creating proper urban image and local branding has also been discussed in this thesis. Suggestions have been made based on regional airport features, through the five directions “path”, “edges”, “nodes”, “landmarks” and “districts”, which are in accordance with Kevin Lynch’s urban image theory.

Fifth, because the research object is the impact of the Berlin Brandenburg International Airport (BER) on its periphery, the last chapter of the main contents focuses on the future BER airport region. A comparative study of the urban status, which includes demographics, land use distribution and economic status of each community in the BER airport region, was made to provide a clear vision of urban status in the BER region. Predictions of

demographic changes, as well as volumes of different land use changes were made according to resultants of linear regression analysis. Analysis of influences of airport-related impact factors on land use distributions were also made in the last chapter. Overall, this study will provide clear planning preconditions or references for politicians, planners and urban researchers for making proper planning and urban development strategies for the BER region. At last, the thesis summarizes the current research programs and development projects being carried out in the BER airport region.

7.2 Perspective of Urban Development in the BER Surroundings

- **Urban status of the BER airport region**

According to the study of the BER airport region, several features could be conclusively identified as related to the urban status in this area.

First, although the new BER airport is not yet opened to the public today, obvious airport-related industry clusters could already be seen in the airport region. The communities of Blankenfelde-Mahlow, Wildau and Ludwigsfelde show an apparent airport-related economic structure, and many aviation industry firms and regional headquarters of large international corporations have already been moved from downtown Berlin or settled their new branches in the airport region. Meanwhile, the BER airport region has a superior ground traffic network and advanced logistic services for passenger transport and cargo transportation, which is a significant inherent advantage for the successful development of the whole airport region.

Second, according to the comparative study of communities in the BER airport region, an imbalanced urban development status could be detected among all BER-adjacent communities. For example, the communities of Eichwalde, Zeuthen and Schulzendorf together form a region with extremely high population and a high proportion of residential land use. However, in these communities the industrial land use is much lower than the mean volume of the airport region, and these communities do not have any preservation land for industrial development by now. Contrarily, the communities of Ludwigsfelde and Grossbeeren have the highest proportion of industrial and business land use, but with few residents at present. Therefore, for the whole BER airport region, the airport could be seen as an opportunity for adjacent communities to adjust their economic as well as land use

structures. The imbalanced developmental status among these communities should be considered seriously.

Third, according to the comparison between the BER airport region and other eight case-study airport regions, considering the smaller capacity of the airport, the BER airport area has a much higher population density than that of the other eight case study regions. On the one hand, the airport zone may provide sufficient labor force for the further development, which could be considered as an advantage. On the other hand, a higher population density in the airport noise contour means that the airport noise impact, as the most negative burden from the airport, will be felt by a higher number of residents. Therefore, airport noise, as the major negative consequence, is more serious in the BER airport region. In this case, noise protection programs are particularly more significant in the BER airport region.

- **Considerations in the BER Airport Regional Planning**

According to the investigation on the developmental process of European case study airports, combined with the status of the BER airport region, several key factors should be considered by decision makers or planners, as follows:

When a newly expanded airport starts operating, a large volume of social, public and private funds begins to flow into the airport region, thus changing the economic structure and land use within a short time period. A large amount of inhabitants, passengers as well as airport noise from the airport and ground access also drastically influence the life style of local residents. Therefore, a compound plan at both regional and community level, based on the estimation of airport impacts and the status quo of the airport region, are greatly needed before the new airport starts operating, in order to avoid superfluous investments of public funds and to create proper land use politics for regional industrial and commercial land use, as well as promote living quality and decrease negative airport impacts on residents.

Although the urban development process in airport regions is more rapid compared to other urban regions, the transformation of communities surrounding a newly opened airport cannot possibly be completed in one phase. Instead, a typical airport region is formed over a long time period, by implementation of different development phases.

The development of an airport region demands a large investment of public funds in social facilities and infrastructure. Such volume of public funds cannot be invested at once before the airport starts operating and enjoying any benefits from it. The land use should also be

gradually planned according to specific demands, in different periods, to form an airport region step by step instead of in a single phase. Therefore, the development plan should be divided into different phases, and in each phase the purpose of the plan should meet the specific demands at the time, thus providing the most efficient planning for local redevelopment.

Plans for airport-surrounding communities should consider the airport region as a whole, and coordination of the development of each community in the airport region plays a significant role in the planning of the area. Before an airport starts operating, the development level of each community in the airport region is most likely not the same. Some communities have a superior basis of industrial and business development, and thus greater potential to become the new urban development hotspots of the region. There are also some communities that lack polar industries or urgently need industrial restructuring. Such communities could use the airport as an activator to establish their new polar industries, hence revitalizing their urban development.

Airports provide a better basis and climate for investments. However, as a regional plan that considers all communities in the airport region as a whole, the planning should not only include how to turn communities with better basis into new hotspots, but also how to use the airport as an opportunity to revitalize communities based on their geographical advantages, thus narrowing the gap between each community and creating a balanced development and coordinated airport region.

In practice, because each influencing factor does not impact a region separately, all factors should be considered coordinately into one strategy at urban planning and designing level. For example, noise protection measurements could be integrated within energy efficiency. Noise protection for traffic corridors could also be integrated with urban branding in the urban planning, to act against the noise burden on local residents, as well as to create new commercial corridors along traffic accesses to provide highly efficient business land use for regional economic developments.

Commonly, the regional planning for the airport region follows the top-bottom way, and mainly considers the development of the whole region as its main concern. Regional planning cannot include more detailed contents at community level, so that such planning is not sufficient to guide communities in their further development. For each airport-surrounding community, regional planning could only indicate the development directions, but not provide more detailed planning based on community status. Therefore, it

is very significant to guarantee a certain degree of flexibility for communities in the airport region, to let them go further steps in the community planning under certain conditions.

Urban development is a continuous, not immutable process. Because the effects of an airport region on urban development are very complex and drastic, the urban development in an airport region will be more dynamic. For example, airport capacity and airport noise contour will directly impact the local land use planning, and the airport capacity changes annually. Taking ground traffic as another example, when the access to an airport is connected, the land use and spatial pattern should also be changed according to the impacts of the new airport access. The status and process of urban development will also influence the further progress of such communities. Therefore, the land use planning should be timely adjusted to the transformations in the airport capacity, and should be more flexible and timeliness, leaving certain potential according to the frequently changing demands of impacts.

Public participation and civic engagement play an increasingly important role in urban design and planning. According to D. Slocombe[209], "opening the opportunity to embrace cultural and social diversity that characterizes the population of the cities today, the development of an operative planning process also implies the inclusion of public participation as active factor in the process of sustainable development". When considering the significance of public participations, "the effective participation of both population and local administration during the entire process is a major factor for its efficiency, since increasing the partaking of the intervening actors prevents the occurrence of potential conflicts, guaranteeing a faster acceptance of the new ideas for urban structure"[210].

For airport regions, public participation is an even more significant part of the planning process.

First, urban design and planning are commonly difficult to be accepted by the public. When an airport begins operating, it leads to a rapid change of the urban spatial formation. Such urban transformation changes the original urban image and identity of airport-adjacent communities. Therefore, in inhabitants of such communities the sense of belonging becomes more or less disrupted, possibly generating public protests against

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[209] D. Slocombe, "Environmental Planning, Ecosystem Science, and Ecosystem Approaches for Environmental Development", Enviromental Management, vol.17 no.3, 1993

[210] M.P. Amado, C.V. Santos, E.B.Moura and V.G. Silva, Public Participation in Sustainable Urban Planning, International Journal of Human and Social Science, 5:2.2010, PP102-107

implementation of the new planning process. However, when public participation is considered in the formulation phase of the planning and the initiative of residents is respected, the planning is more easily accepted by the public, which relieves the pressure of its implementation.

Second, history, culture, heritage and life style together form urban identity, which are important elements of "soft power" in future urban development. Traditional urban texture as well is an important element for continuation of the urban context in the development process. It has been proven by many airport region development cases that such a large-scale civic infrastructure as an airport will drastically change the urban identity of the whole region. However, well-operated public participation and integration of civic engagement in the planning process are efficient tools to avoid the disruption of urban identity and urban context in the urban planning process.

Therefore, public participation gains even more significance in the airport region planning process. Public participation activities such as forums and dialogs in each decision-making process would efficiently avoid developmental risks and achieve easier public acceptance.

7.3 **Further Research Questions**

The main content of the dissertation at hand is the focus on impacts of major European international airports on their surrounding urban regions, based on eight airport case studies. It also takes the Berlin Brandenburg Airport region as a test field for implementation of the research findings. Due to limitations of time and methodology, many research questions are not studied in depth or are not answered. Therefore, a refinement, deepening or extension is needed in further studies.

- **Research on Outliers**

The aim of this dissertation was to investigate, by the methodology of linear regression, the common correlations between airport impacts and the urban status of airport cities in European regions. Therefore, in order to find out the refined linear-correlated model, several outliers have been excluded in the linear regression analysis.

The present dissertation only marginally discusses the outliers, not studying them in depth. For example, when shaping the linear correlation between the airports' annual passenger number and the commercial clusters in the airport regions, the Amsterdam Schiphol and the Paris Orly airports were considered outliers, with extremely high proportion of commercial development compared to their air cargo capacity. However, in explaining the

reasons for the successful commercial development in these two airports, the author only introduced the existing analyses from airport authorities, but did not carry out a comprehensive study. Although not the main purpose of the dissertation, outliers like these could be well studied in the future to investigate the impacting factors for a commercial success in airport regions.

- **Regression Study in a Wider Range**

As mentioned before, this thesis is mainly focused on major European airports, based on similarities among these airports' development strategies, policies and human conditions. However, beyond the geographical restrictions, there are similarities and differences in between, for instance as concerns European, American, Australian and Asian airport development models and policies and the corresponding urban progress of airport-adjacent areas in the different regions. Therefore, based on the same methodologies used in this dissertation, a comparative study could be carried out in a wider range to discuss the similarities and differences of airport development policy impacts on their urban regions. In conclusion, the common correlation between airport repercussions on adjacent regions and the differences in urban status of the airport region corresponds to different airport development and land development policies.

- **Study on the Integration of Residents' Participation in Development Processes**

There is no doubt that an airport is a regional development engine. However, an airport is a double-edged sword for urban development in airport-adjacent regions. In fact, airport development is the most controversial of urban development projects, and social protests against airport developments could be seen in nearly every airport region. Therefore, one of the most important tasks for urban planners and decision makers responsible for regional airport developments is to ensure the life quality of the airport region for local residents, so as to obtain a good reputation for further regional airport developments, as well as to create a sense of security to retain local inhabitants.

Residents' participation in the development process is an effective tool in urban progress. It also respects the view of local residents to the maximum, to ensure the diversity of urban development and thus obtain great social benefits and reputation in urban developments. However, during the making of this study, residents' participation in the development of their communities in airport regions was not broadly considered yet.

Therefore, a study is urgently needed to discuss about with which methods, at which level and with which guidance residents would participate in the airport region, and how to

organize the residential practice in the airport's regional development to effectively reduce the social protests against these developments and create a livable urban quality for local residents.

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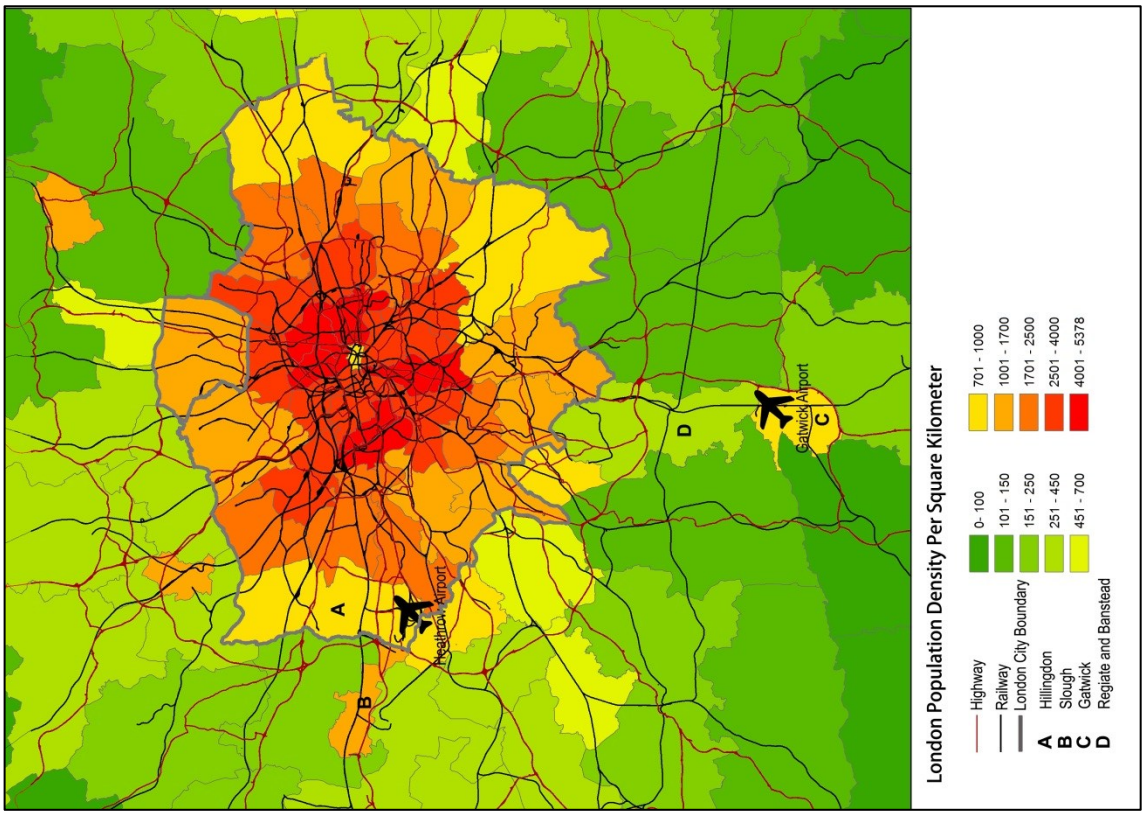
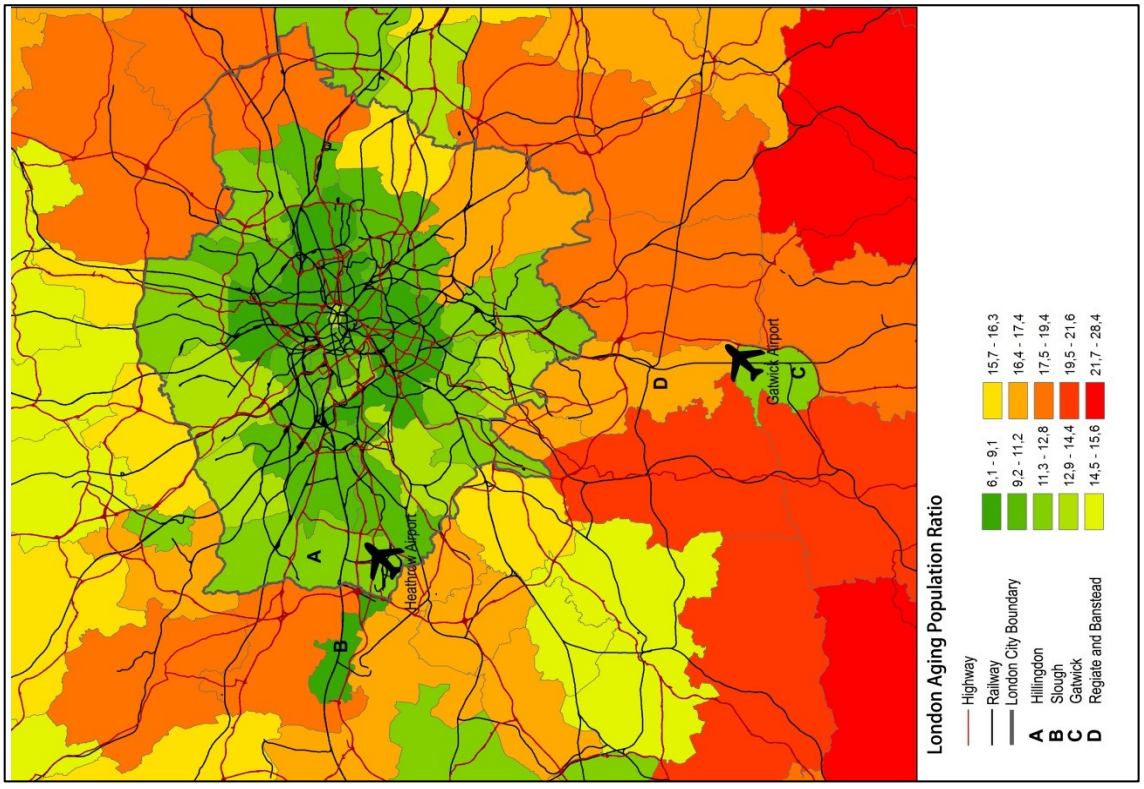
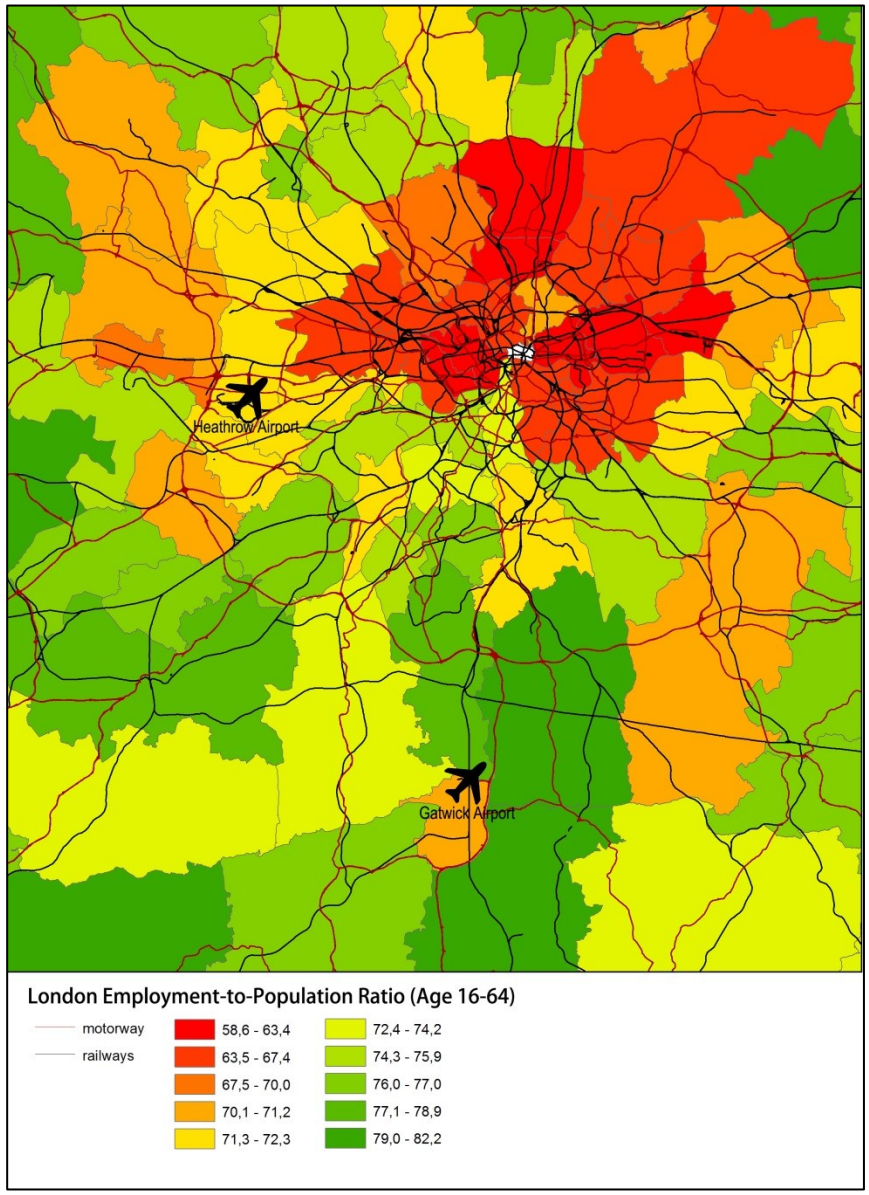
List of Figures

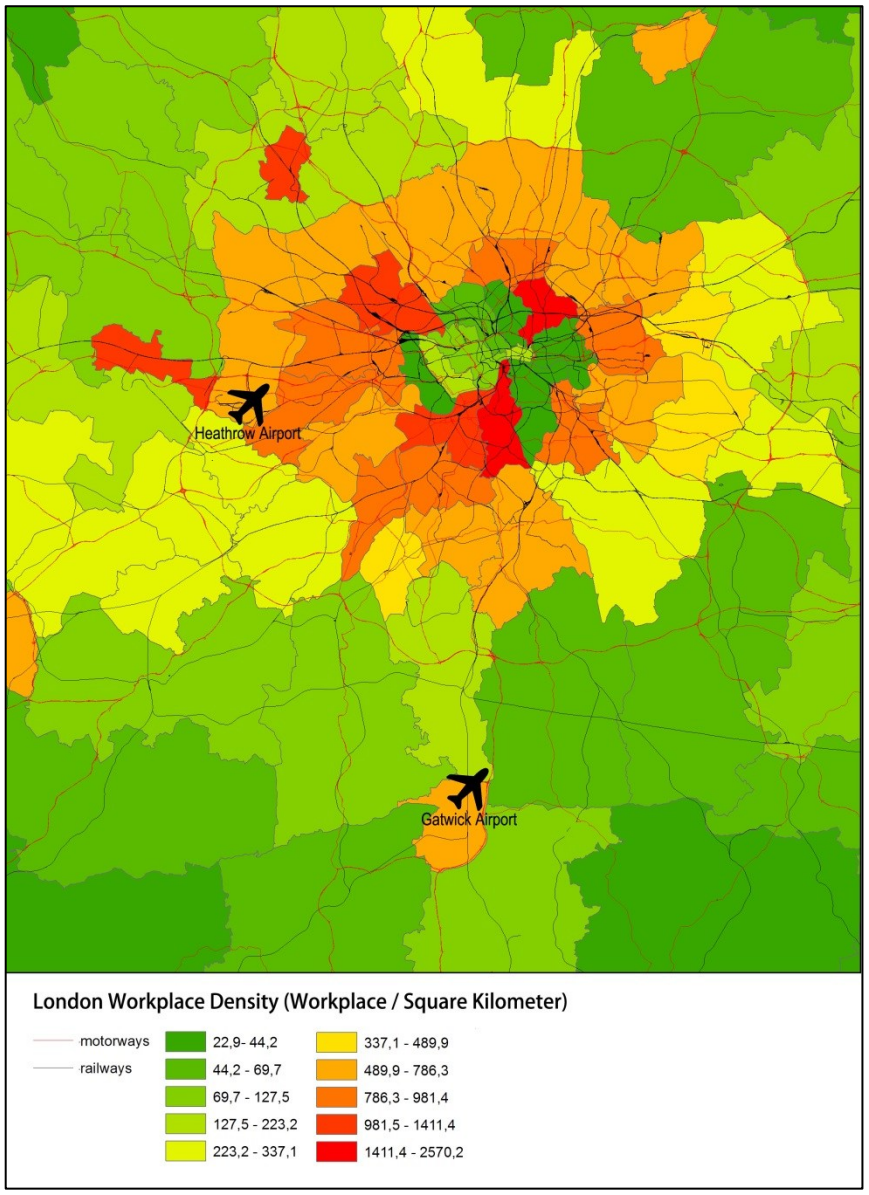
List of Tables

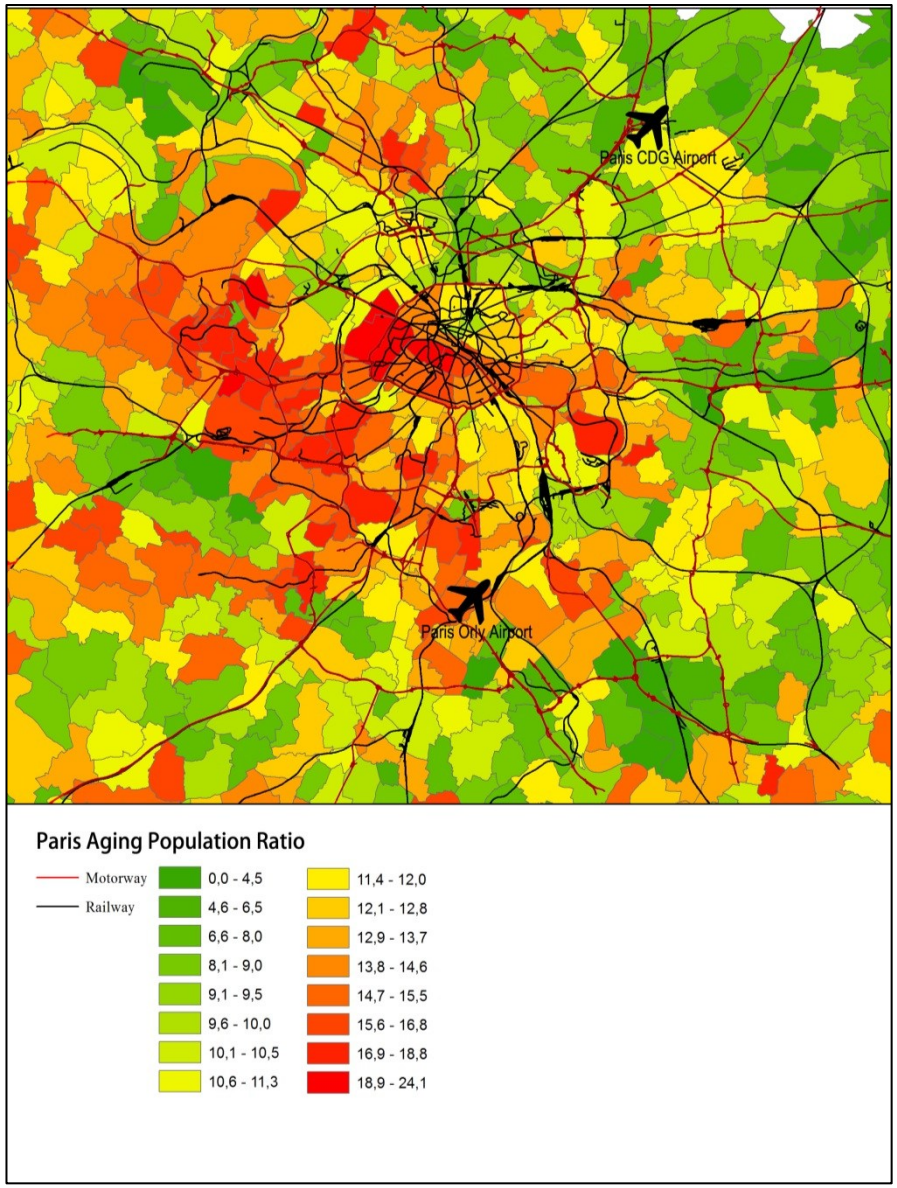
Appendix 1 – Social Structure Analysis of Case Study Airport Regions

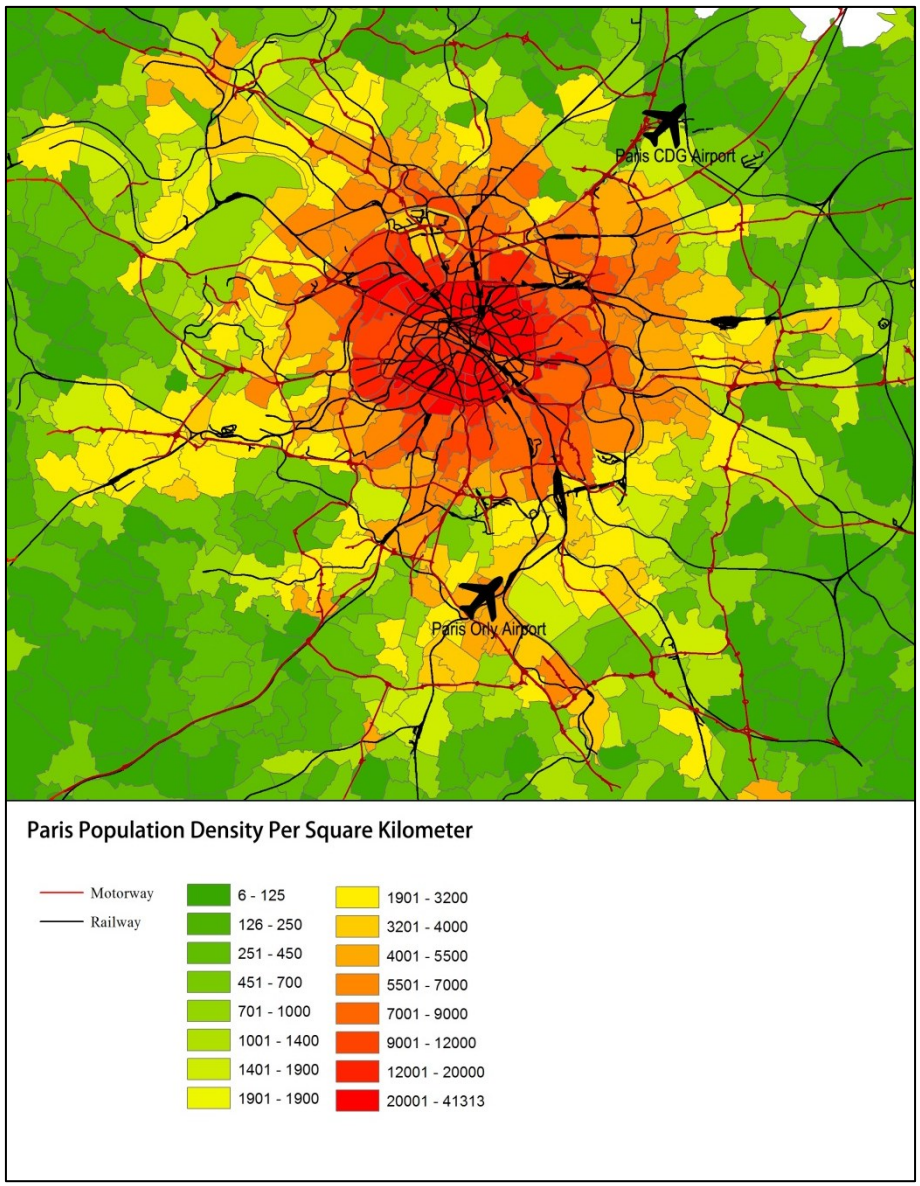


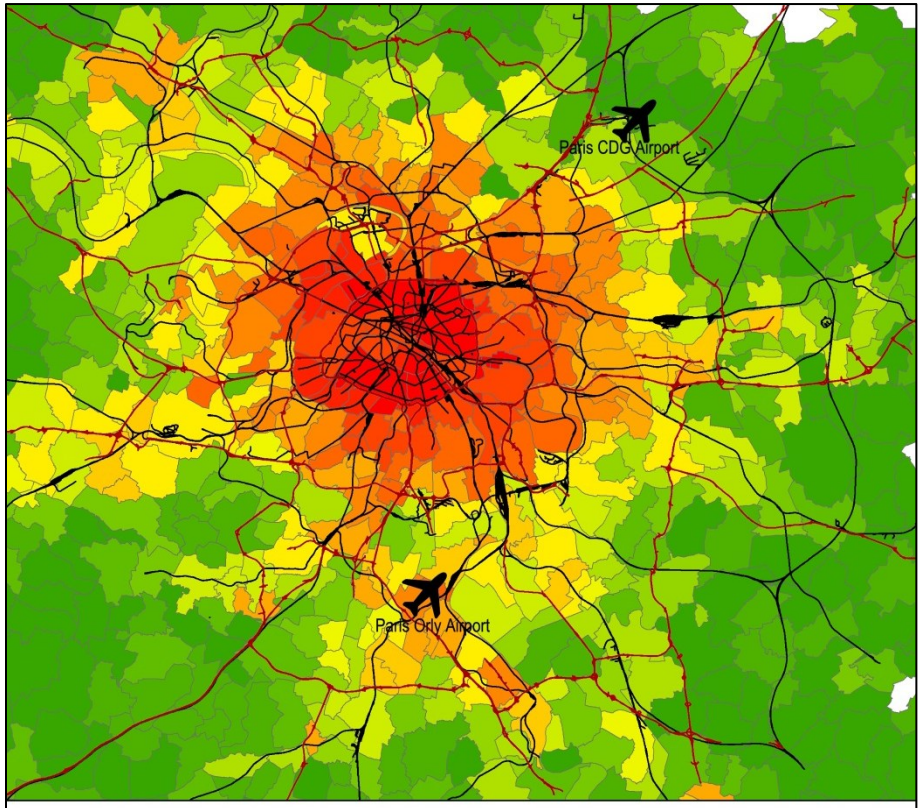



Heathrow Airport
Gatwick Airport
London Employment-to-Population Ratio (Age 16-64)
motorway
railways
58,6 - 63,4
63,5 - 67,4
67,5 - 70,0
70,1 - 71,2
71,3 - 72,3
72,4 - 74,2
74,3 - 75,9
76,0 - 77,0
77,1 - 78,9
79,0 - 82,2


Heathrow Airport
Gatwick Airport
London Workplace Density (Workplace / Square Kilometer)
motorways
railways
22,9- 44,2
44,2 - 69,7
69,7 - 127,5
127,5 - 223,2
223,2 - 337,1
337,1 - 489,9
489,9 - 786,3
786,3 - 981,4
981,5 - 1411,4
1411,4 - 2570,2

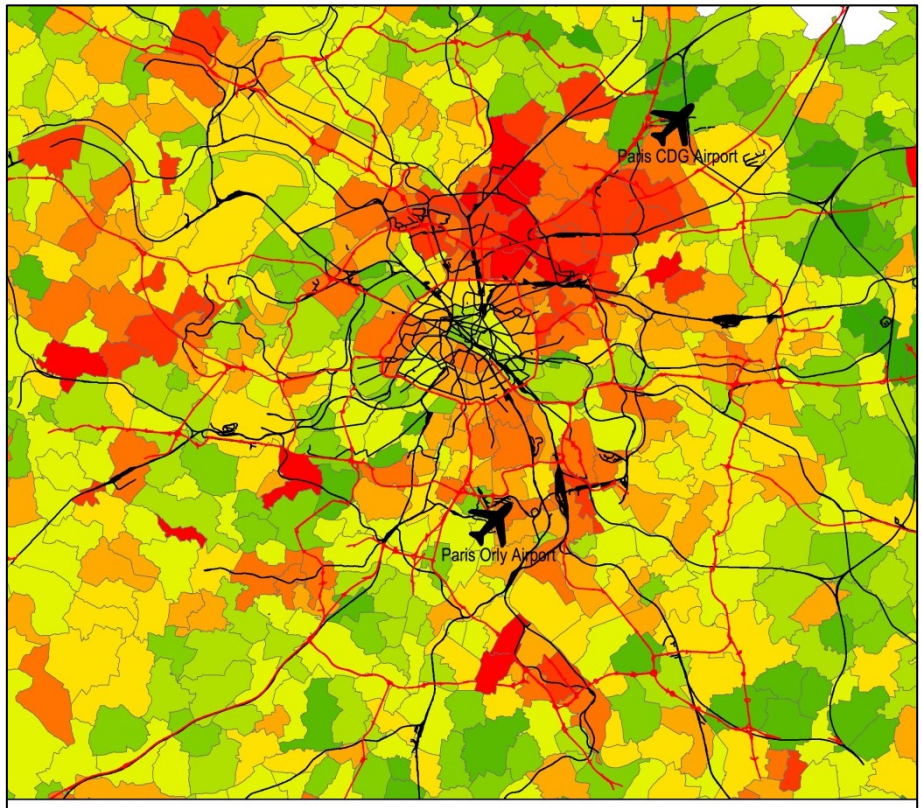

Paris CDG Airport
Paris Orly Airport
Paris Aging Population Ratio
Motorway
Railway
0,0 - 4,5
4,6 - 6,5
6,6 - 8,0
8,1 - 9,0
9,1 - 9,5
9,6 - 10,0
10,1 - 10,5
10,6 - 11,3
11,4 - 12,0
12,1 - 12,8
12,9 - 13,7
13,8 - 14,6
14,7 - 15,5
15,6 - 16,8
16,9 - 18,8
18,9 - 24,1


Paris CDG Airport
Paris Orly Airport
Paris Population Density Per Square Kilometer
Motorway
Railway
6 - 125
126 - 250
251 - 450
451 - 700
701 - 1000
1001 - 1400
1401 - 1900
1901 - 1900
1901 - 3200
3201 - 4000
4001 - 5500
5501 - 7000
7001 - 9000
9001 - 12000
12001 - 20000
20001 - 41313



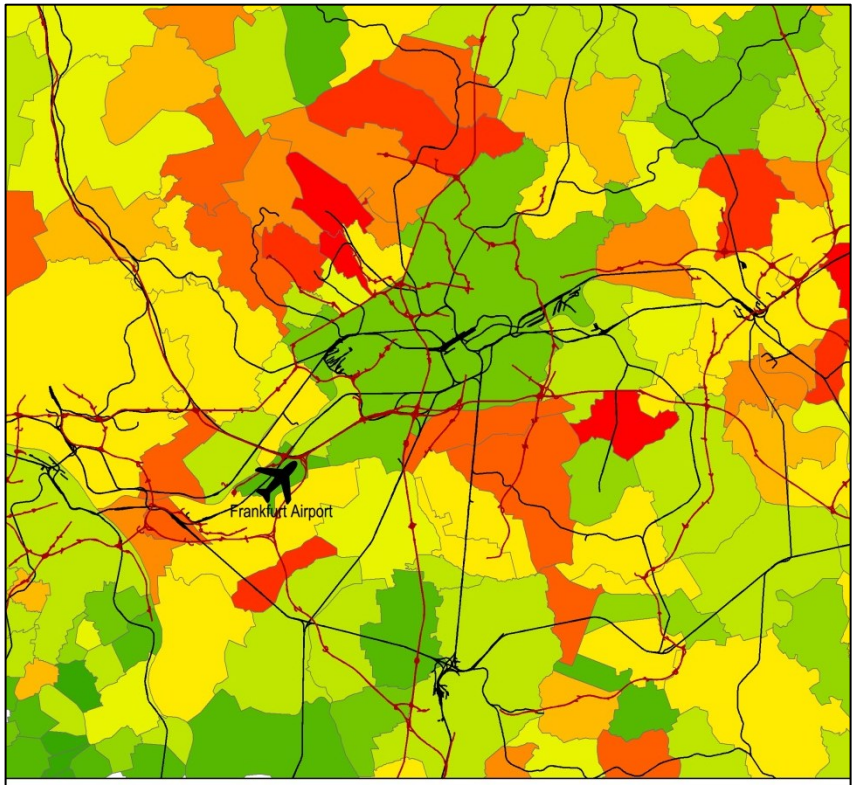
Paris Workplace Density (Workplace / Square Kilometer)

Motorway	4 - 75	1101 - 1500
Railway	76 - 150	1501 - 1800
	151 - 250	1801 - 2400
	251 - 350	2401 - 2900
	351 - 500	2901 - 4050
	501 - 700	4051 - 6500
	701 - 950	6501 - 11000
	951 - 1100	11001 - 22137



Paris Empolyment-to-Population Ratio (Age 16-64)

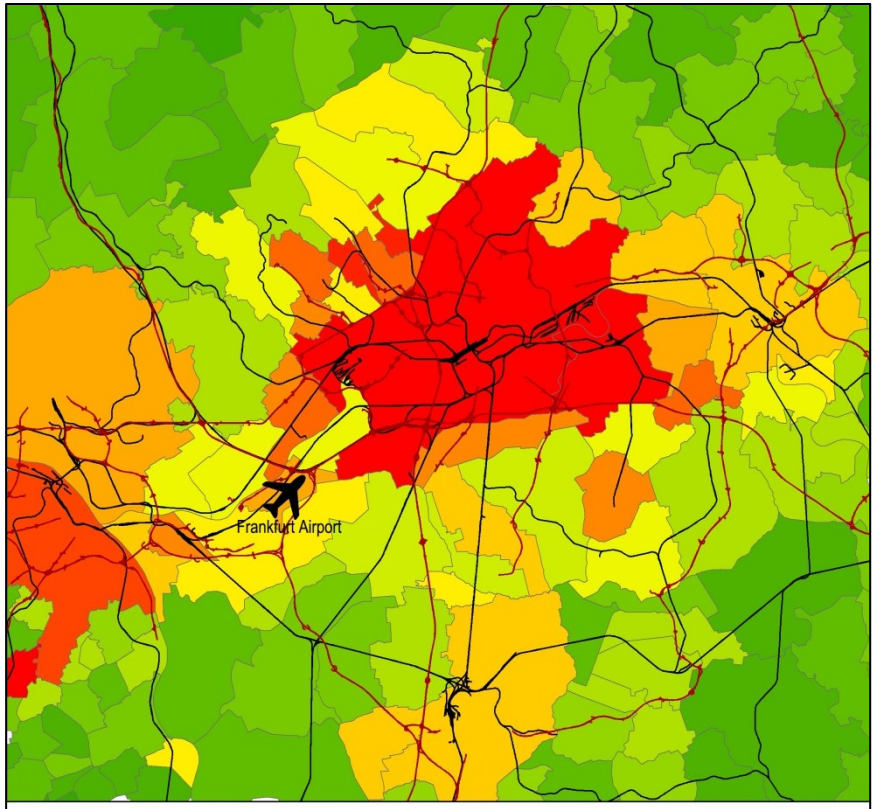
Motorway	36,8 - 55,3	69,4 - 71,0
Railway	55,4 - 61,2	71,1 - 72,7
	61,3 - 64,9	72,8 - 74,8
	65,0 - 67,5	74,9 - 77,8
	67,6 - 69,3	77,9 - 85,1



Frankfurt Aging Population Ratio

Motorway
Rail

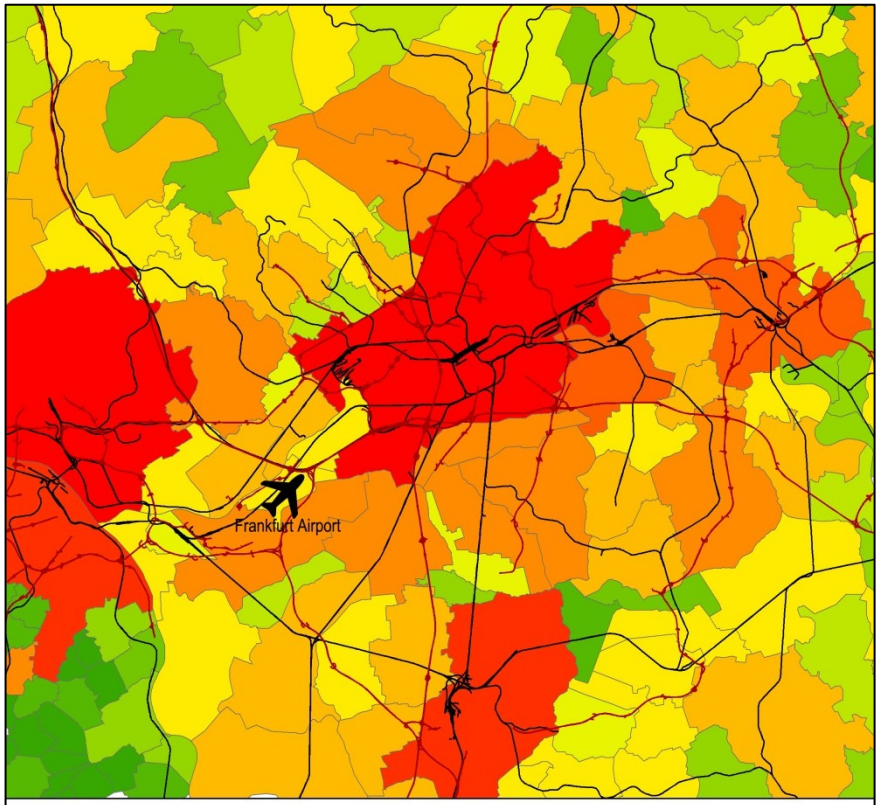
12,8 - 14,0	19,1 - 20,0
14,1 - 16,0	20,1 - 20,5
16,1 - 17,0	20,6 - 21,5
17,1 - 17,5	21,6 - 22,5
17,6 - 18,5	22,6 - 24,0
18,6 - 19,0	24,1 - 28,5



Frankfurt Population Density Per Square Kilometer

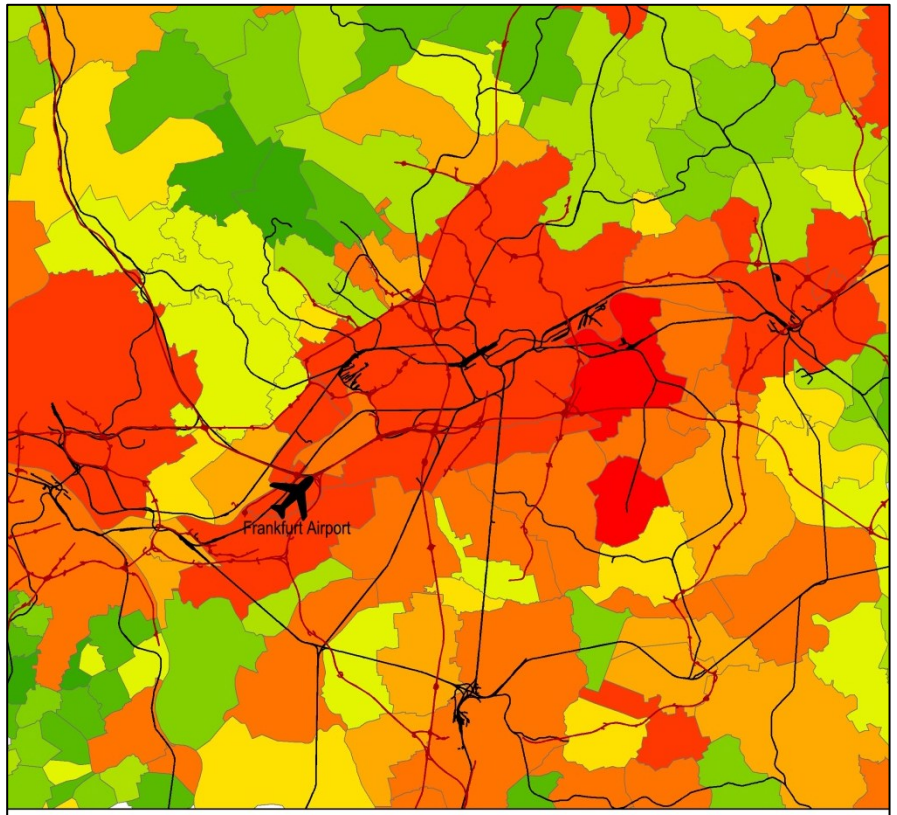
Motorway
Rail

36,2 - 50,0	401 - 450
50,1 - 100	451 - 500
101 - 150	501 - 550
151 - 200	551 - 650
201 - 250	651 - 750
251 - 300	751 - 850
301 - 350	851 - 1000
351 - 400	1010 - 1210



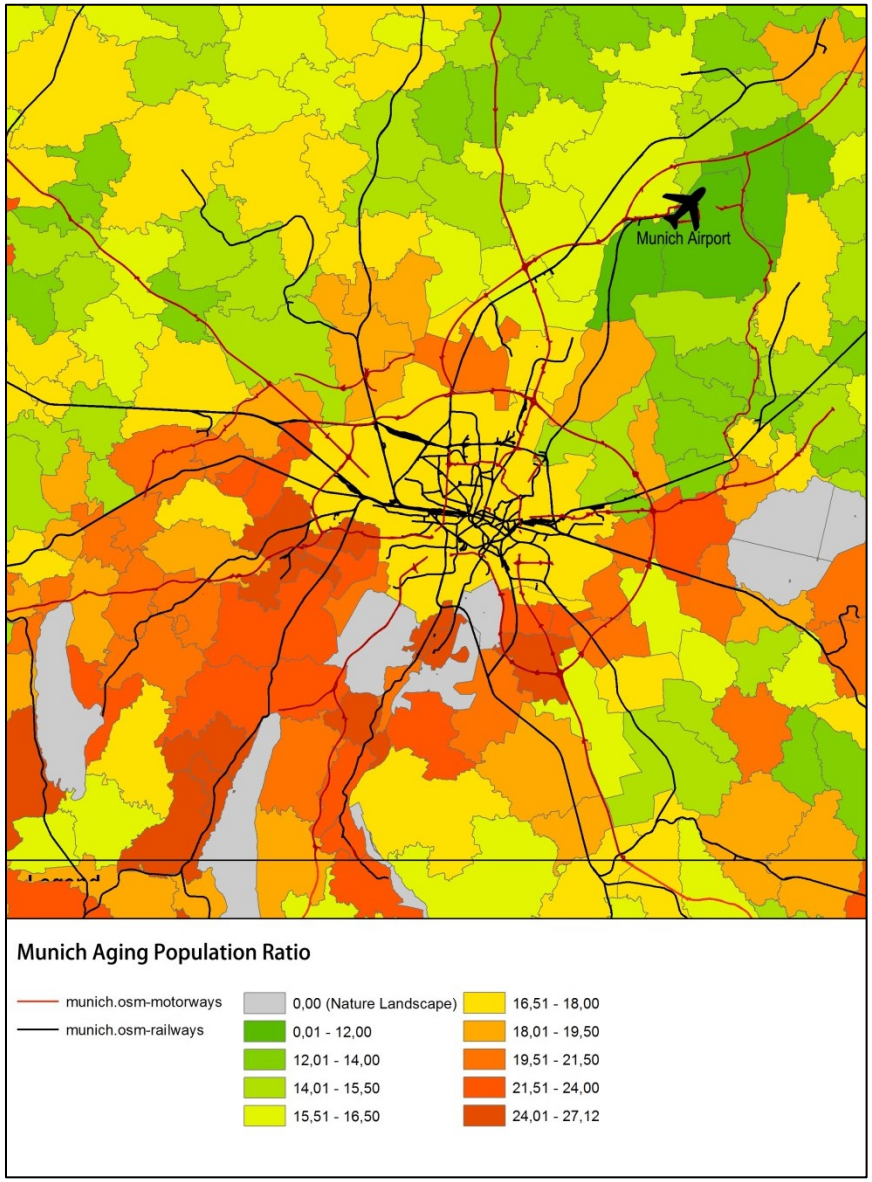
Frankfurt Workplace Density (Workplace / Square Kilometer)

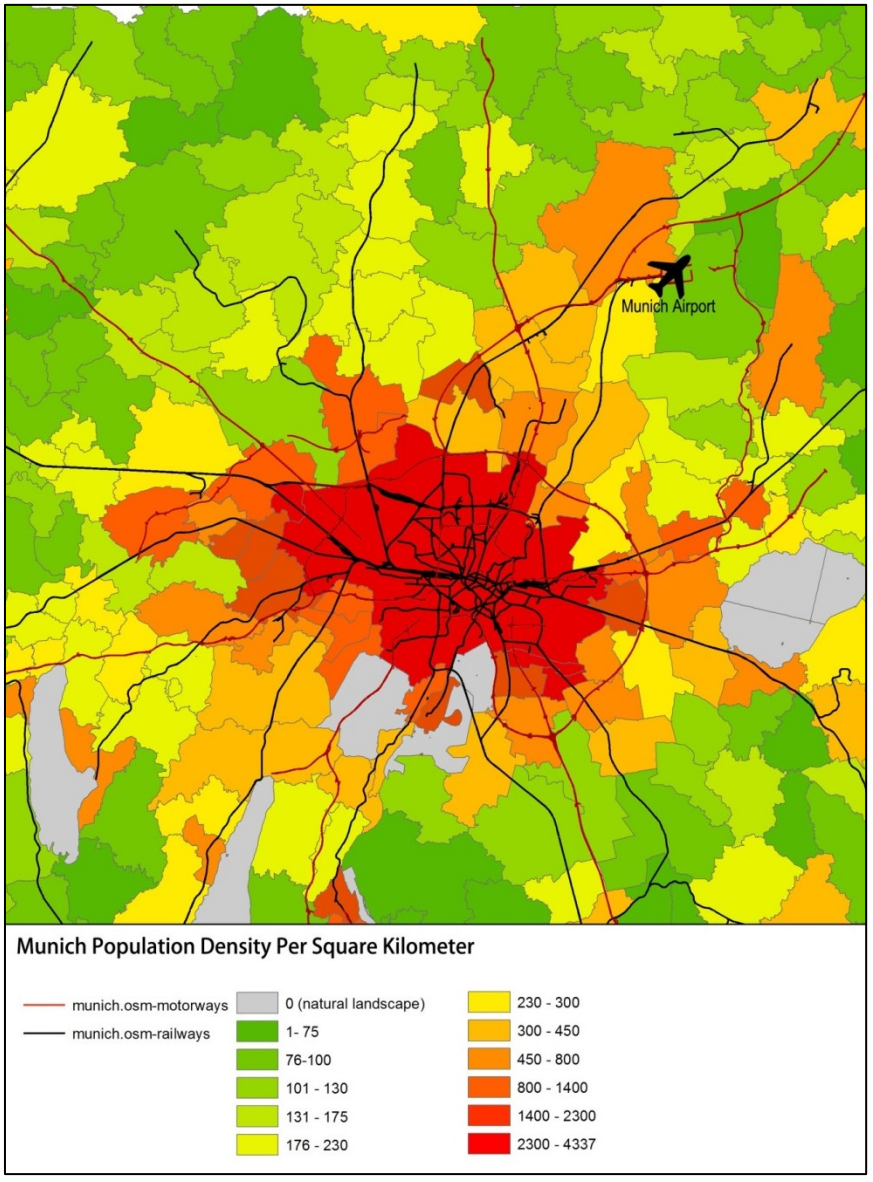
Motorway	407 - 1285	6916 - 10495
Rail	1286 - 2445	10496 - 17090
	2446 - 3575	17091 - 29585
	3576 - 4515	29586 - 79075
	4516 - 5855	79076 - 144550
	5856 - 6915	144551 - 376010

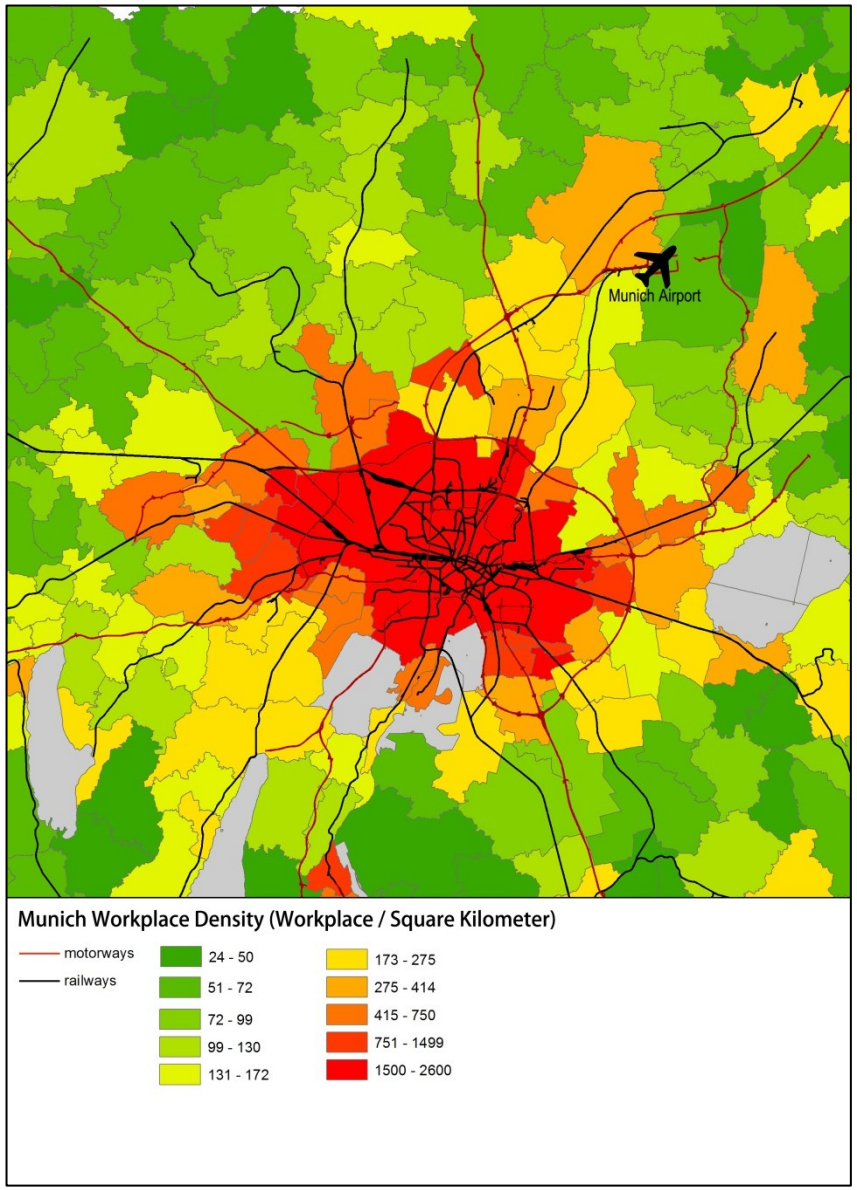


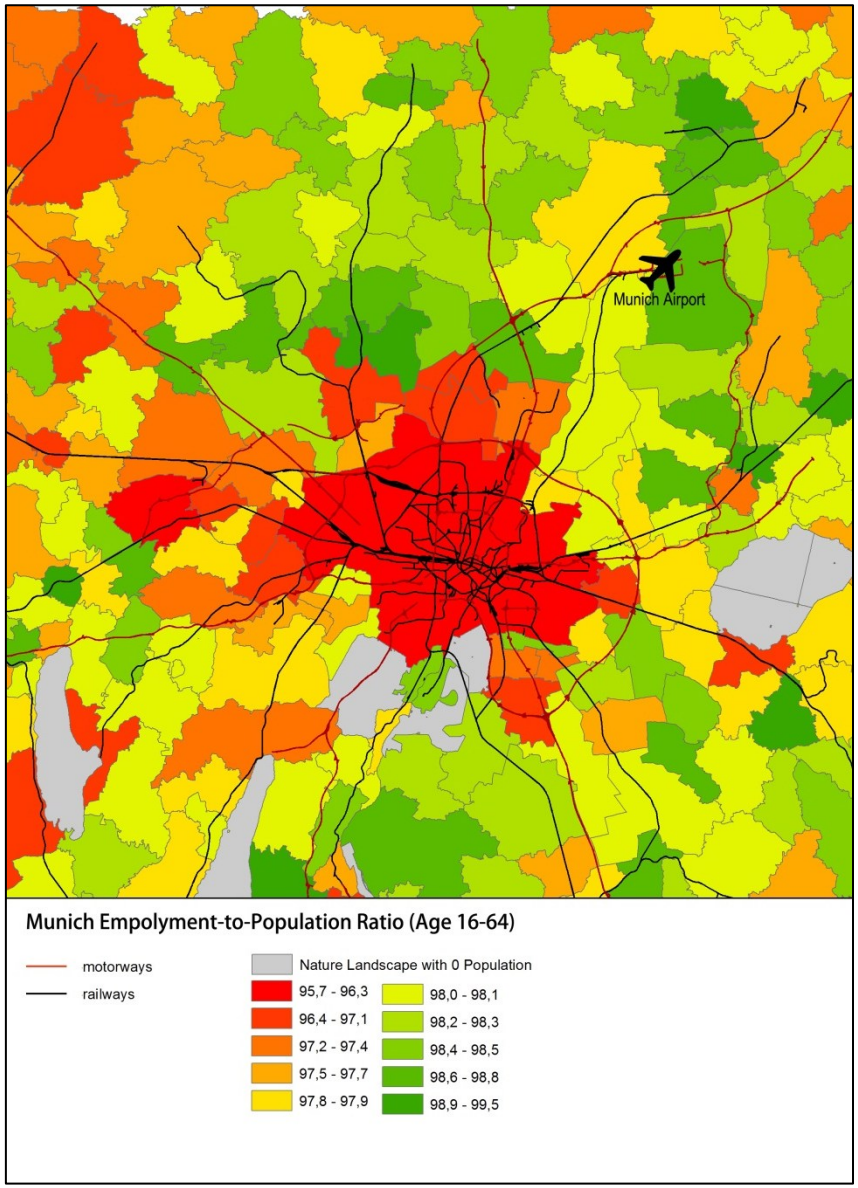
Frankfurt Empolyment-to-Population Ratio (Age 16-64)

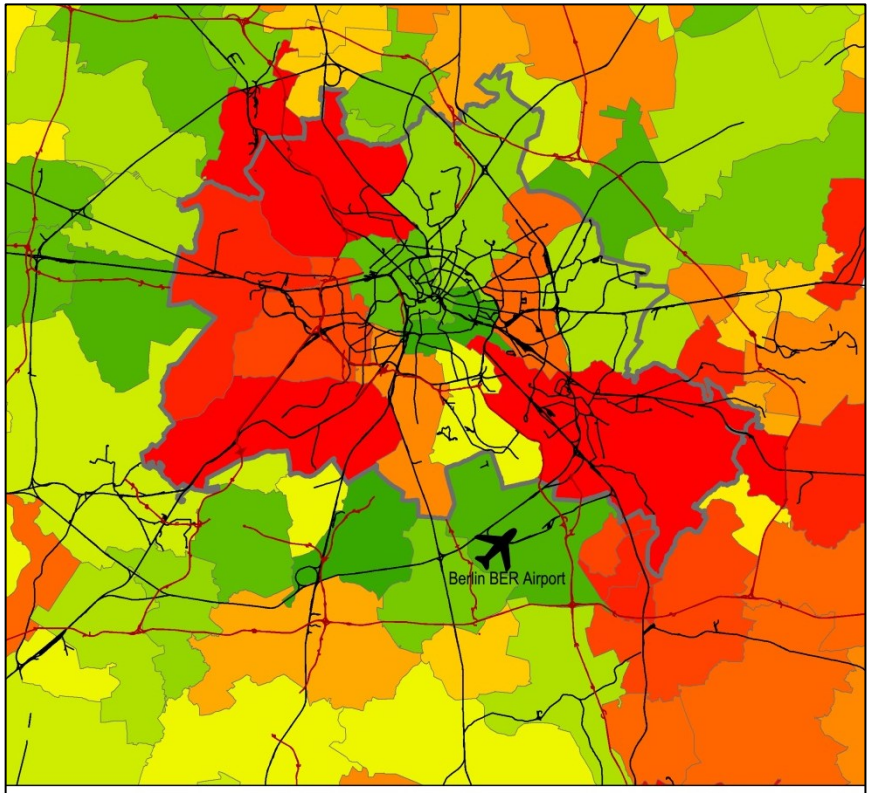
Motorway	91,1 - 91,2	96,6 - 96,9
Rail	91,3 - 94,4	97,0 - 97,1
	94,5 - 95,5	97,2 - 97,5
	95,6 - 96,1	97,6 - 98,0
	96,2 - 96,5	98,1 - 99,2


Munich Airport
Munich Aging Population Ratio
munich.osm-motorways
munich.osm-railways
0,00 (Nature Landscape)
0,01 - 12,00
12,01 - 14,00
14,01 - 15,50
15,51 - 16,50
16,51 - 18,00
18,01 - 19,50
19,51 - 21,50
21,51 - 24,00
24,01 - 27,12


Munich Airport
Munich Population Density Per Square Kilometer
munich.osm-motorways
munich.osm-railways
0 (natural landscape)
1- 75
76-100
101 - 130
131 - 175
176 - 230
230 - 300
300 - 450
450 - 800
800 - 1400
1400 - 2300
2300 - 4337


Munich Airport
Munich Workplace Density (Workplace / Square Kilometer)
motorways
railways
24 - 50
51 - 72
72 - 99
99 - 130
131 - 172
173 - 275
275 - 414
415 - 750
751 - 1499
1500 - 2600

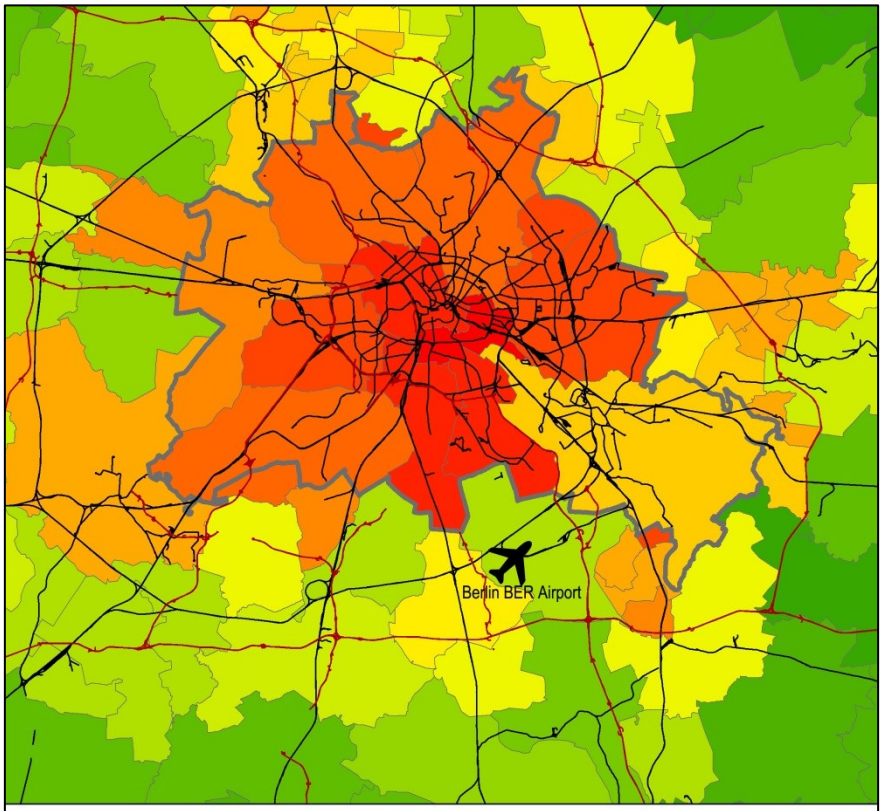

Munich Airport
Munich Empolyment-to-Population Ratio (Age 16-64)
motorways
railways
Nature Landscape with 0 Population
95,7 - 96,3
96,4 - 97,1
97,2 - 97,4
97,5 - 97,7
97,8 - 97,9
98,0 - 98,1
98,2 - 98,3
98,4 - 98,5
98,6 - 98,8
98,9 - 99,5



Berlin Aging Population Ratio

- Motorway
- Raiwaly
- Berlin City Region

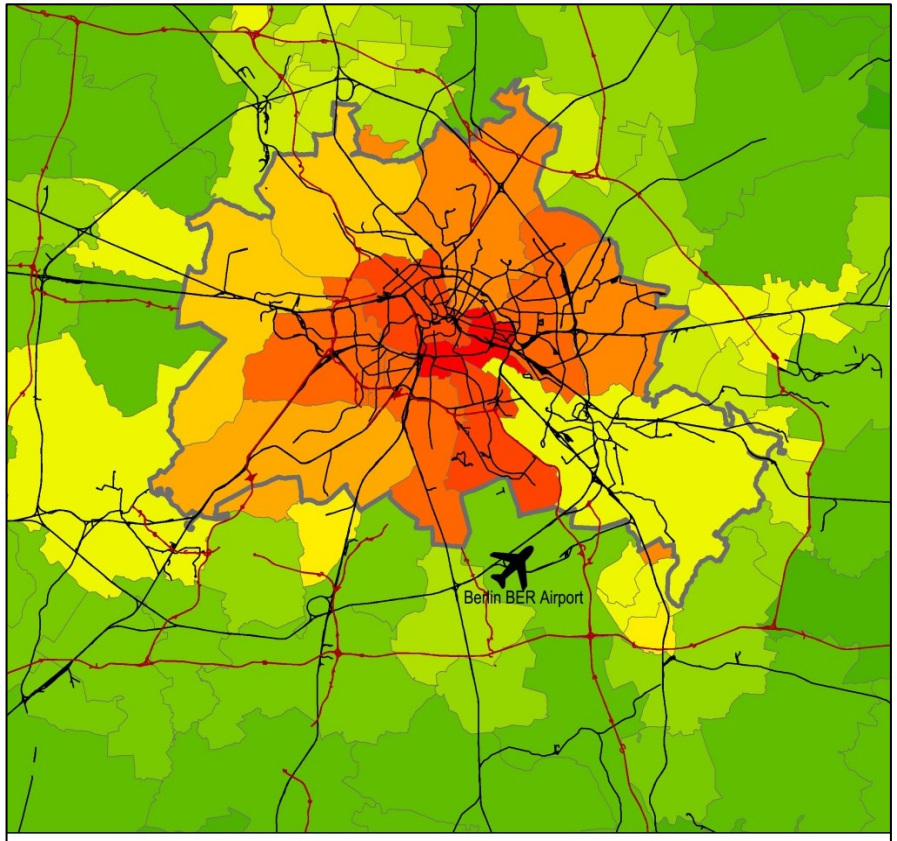
0,0	10,1 - 10,5
0,1 - 4,0	10,6 - 11,0
4,1 - 6,6	11,1 - 11,5
6,7 - 7,0	11,6 - 12,5
7,1 - 7,5	12,6 - 13,5
7,6 - 8,5	13,6 - 15,5
8,6 - 9,0	15,6 - 18,0
9,1 - 10,0	18,1 - 21,0



Berlin Population Density per Square Kilometer

- Motorway
- Raiwaly
- Berlin City Region

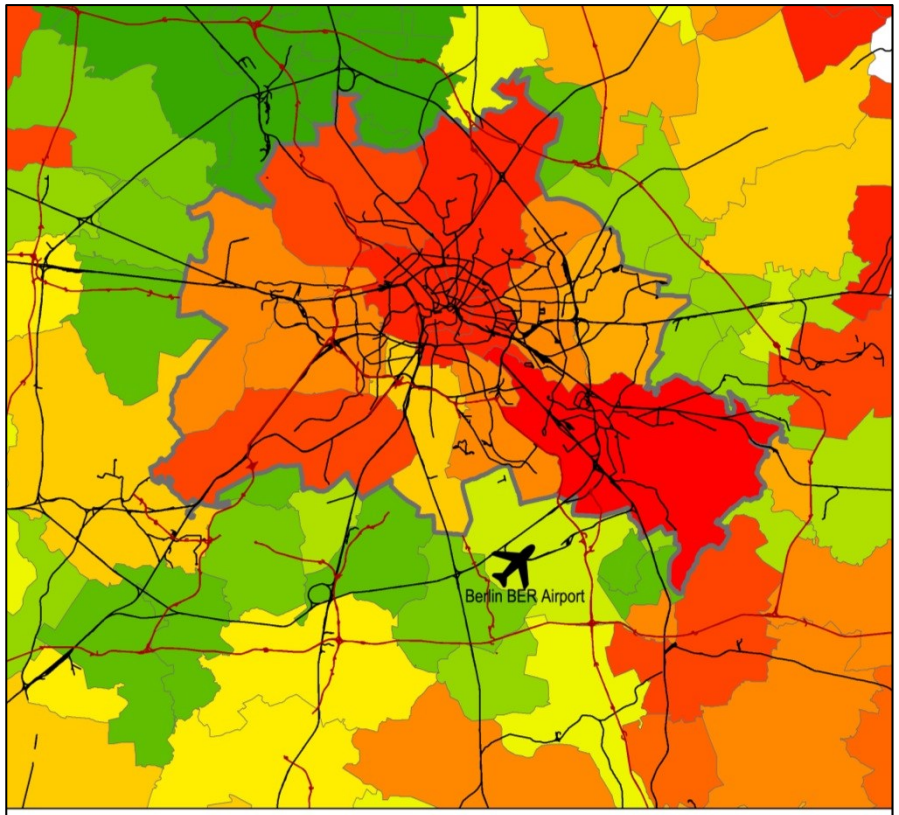
0,0 - 7,00	151 - 195
7,01 - 20,0	196 - 275
20,1 - 27,5	276 - 345
27,6 - 35,0	346 - 455
35,1 - 55,0	456 - 660
55,1 - 70,0	661 - 925
70,1 - 90,0	926 - 1480
90,1 - 150	1490 - 2290



Berlin Workplace Density (Workplace / Square Kilometer)

- Motorway
- Raiwaly
- Berlin City Region

1,8 - 3,5	210,1 - 277,0
3,6 - 7,5	277,1 - 326,0
7,6 - 32,5	326,1 - 401,5
32,6 - 50,5	401,6 - 562,0
50,6 - 85,5	562,1 - 815,0
85,6 - 121,5	815,1 - 1091,0
121,6 - 166,5	1091,1 - 1402,0
166,6 - 210,0	1402,1 - 1723,6

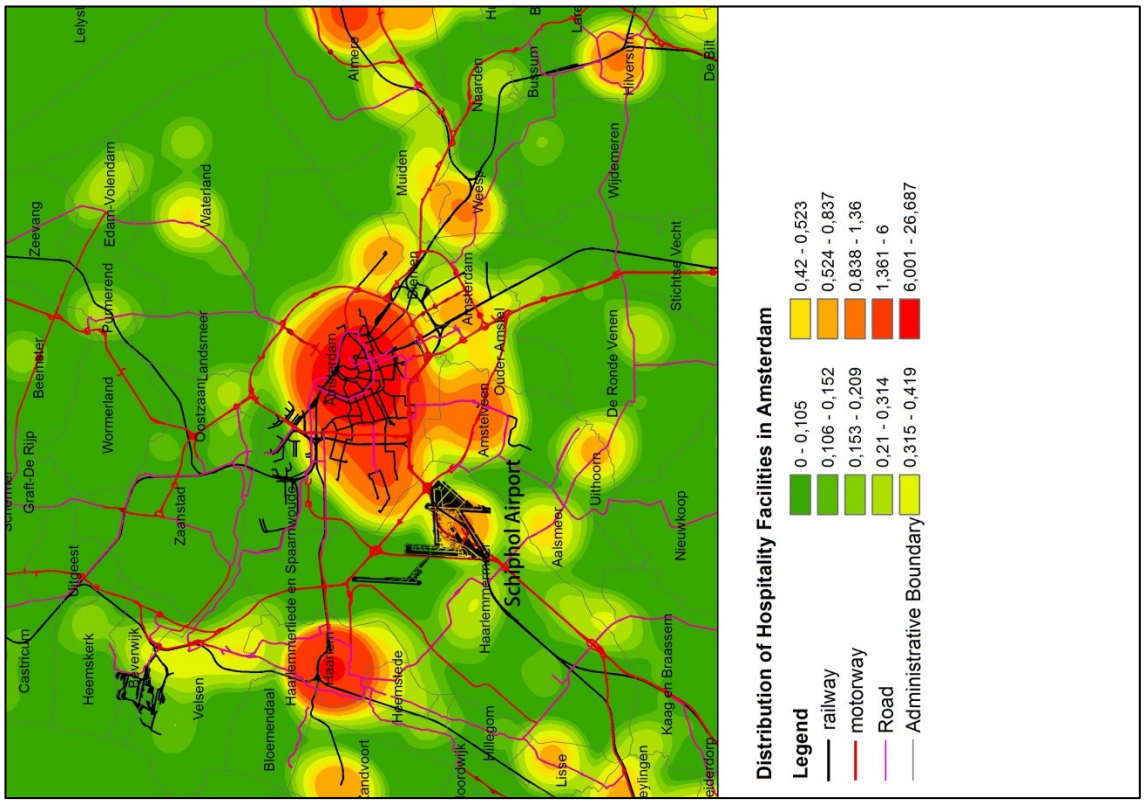


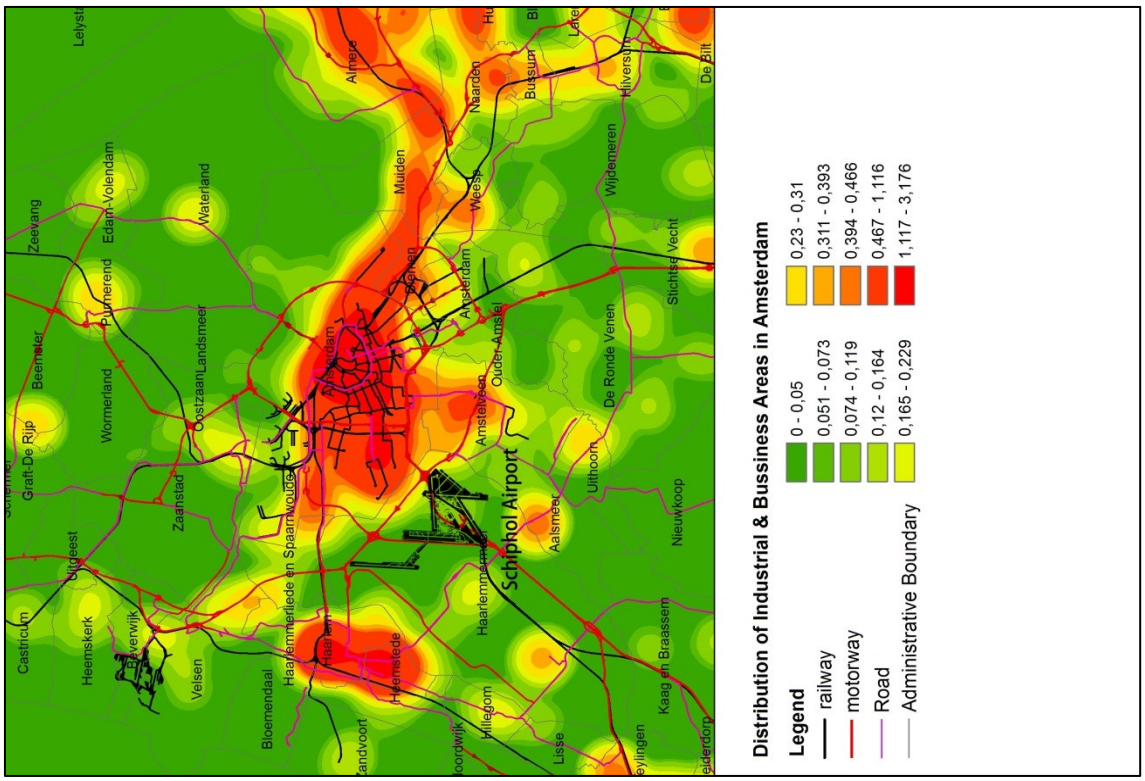
Berlin Unemployment Ratio

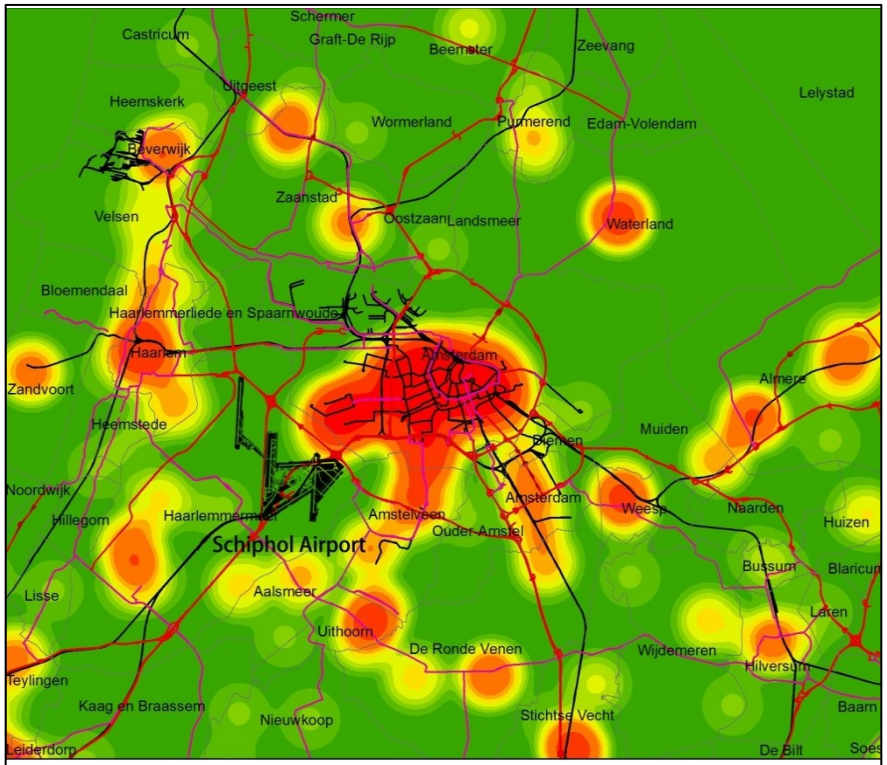
- Motorway
- Raiwaly
- Berlin City Region

0,0	10,1 - 10,5
0,1 - 4,0	10,6 - 11,0
4,1 - 6,6	11,1 - 11,5
6,7 - 7,0	11,6 - 12,5
7,1 - 7,5	12,6 - 13,5
7,6 - 8,5	13,6 - 15,5
8,6 - 9,0	15,6 - 18,0
9,1 - 10,0	18,1 - 21,0

Appendix 2 – Kernel Density Analysis of Case Study Airport Regions





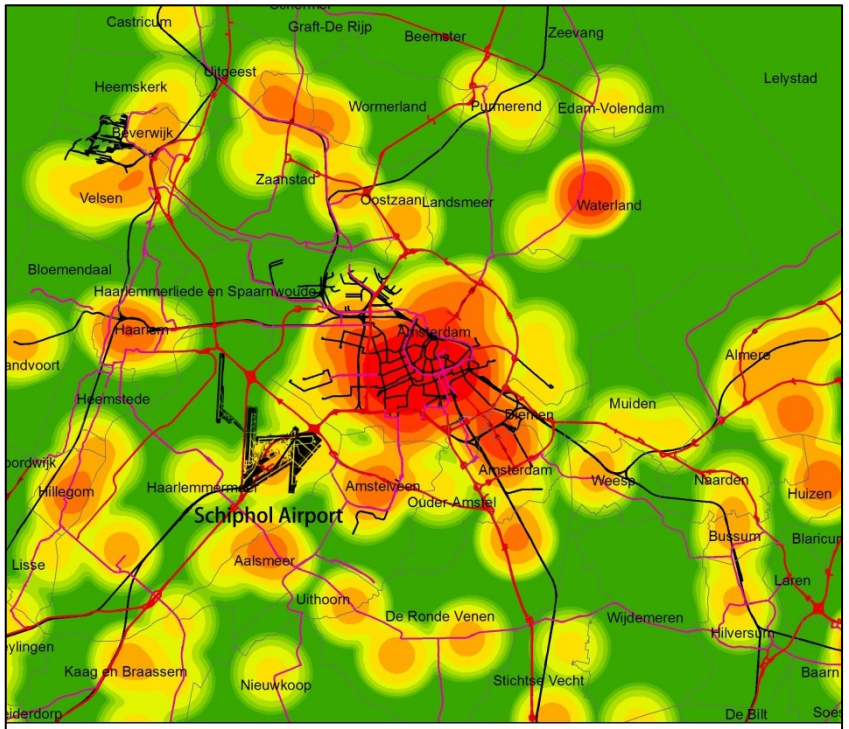


Distribution of Higher Educational and Research Facilities in Amsterdam

Legend

- railway
- motorway
- Road
- Administrative Boundary

0 - 0,016	0,123 - 0,154
0,017 - 0,042	0,155 - 0,187
0,043 - 0,061	0,188 - 0,287
0,062 - 0,087	0,288 - 0,467
0,088 - 0,122	0,468 - 1,119

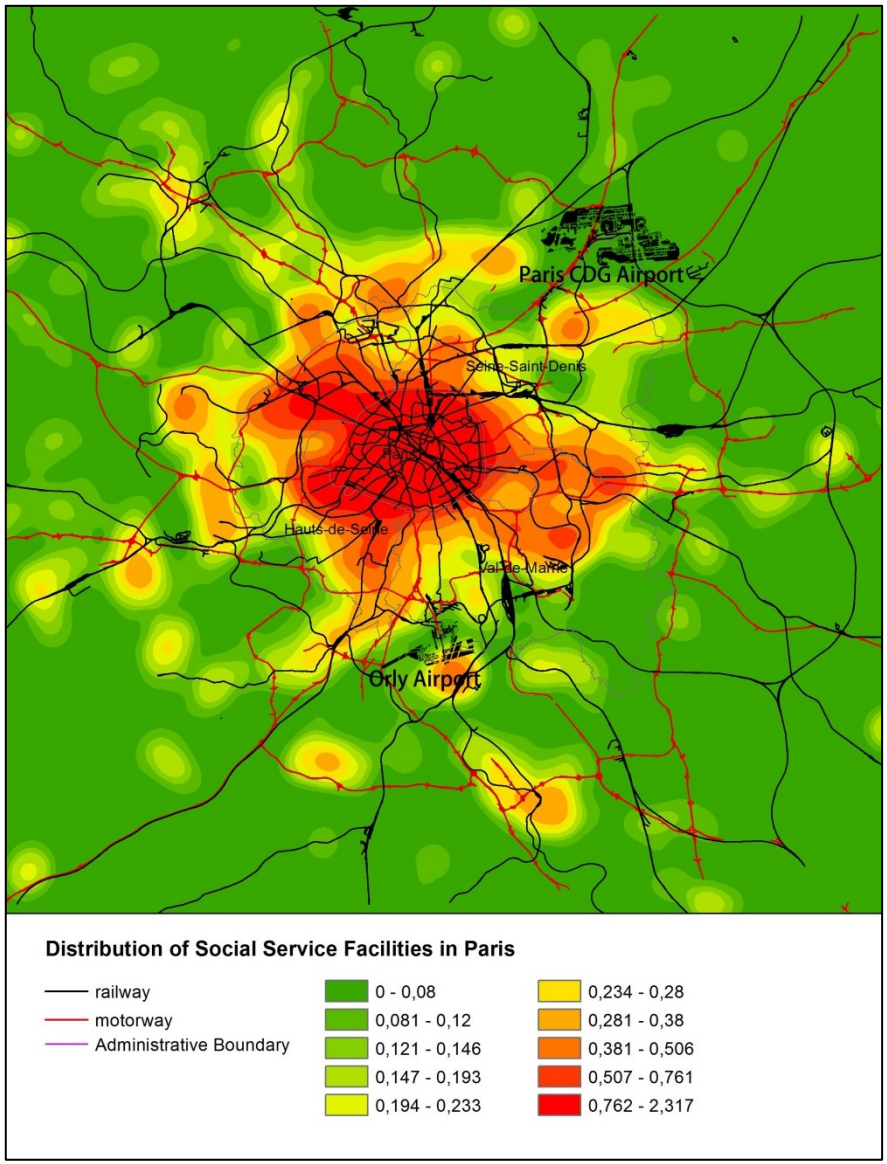


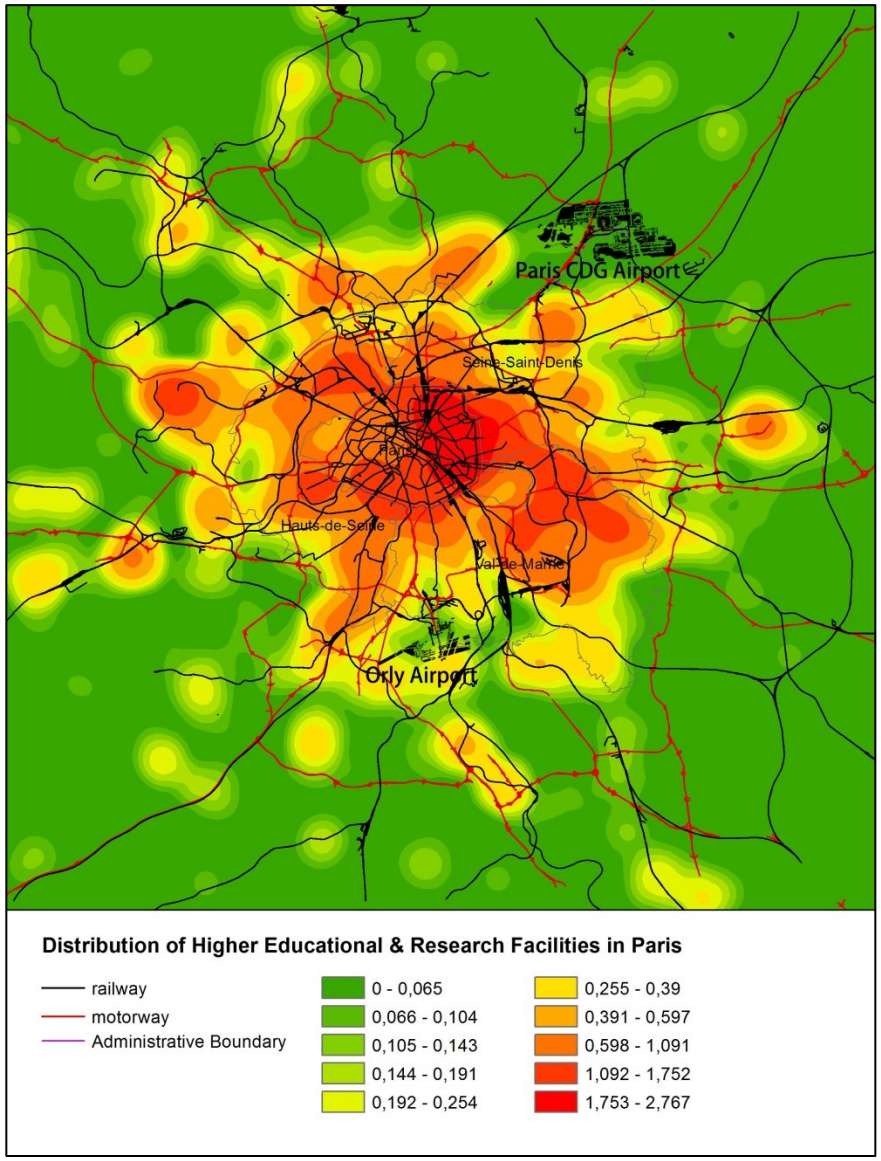
Distribution of Social Service Facilities in Amsterdam

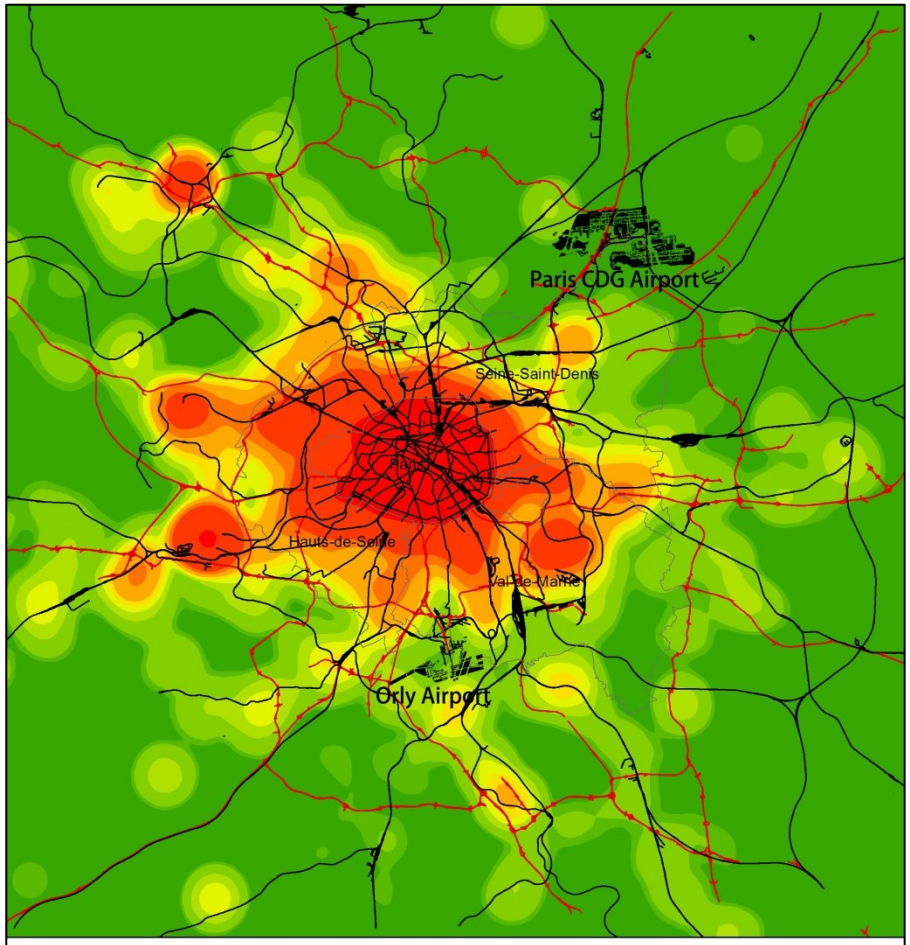
Legend

- railway
- motorway
- Road
- Administrative Boundary

0 - 0,002	0,037 - 0,066
0,003 - 0,005	0,067 - 0,12
0,006 - 0,01	0,121 - 0,216
0,011 - 0,019	0,217 - 0,388
0,02 - 0,036	0,389 - 0,694


Paris CDG Airport
Seine-Saint-Denis
Paris
Hauts-de-Seine
Val-de-Marne
Orly Airport
Distribution of Social Service Facilities in Paris
railway
motorway
Administrative Boundary
0 - 0,08
0,081 - 0,12
0,121 - 0,146
0,147 - 0,193
0,194 - 0,233
0,234 - 0,28
0,281 - 0,38
0,381 - 0,506
0,507 - 0,761
0,762 - 2,317

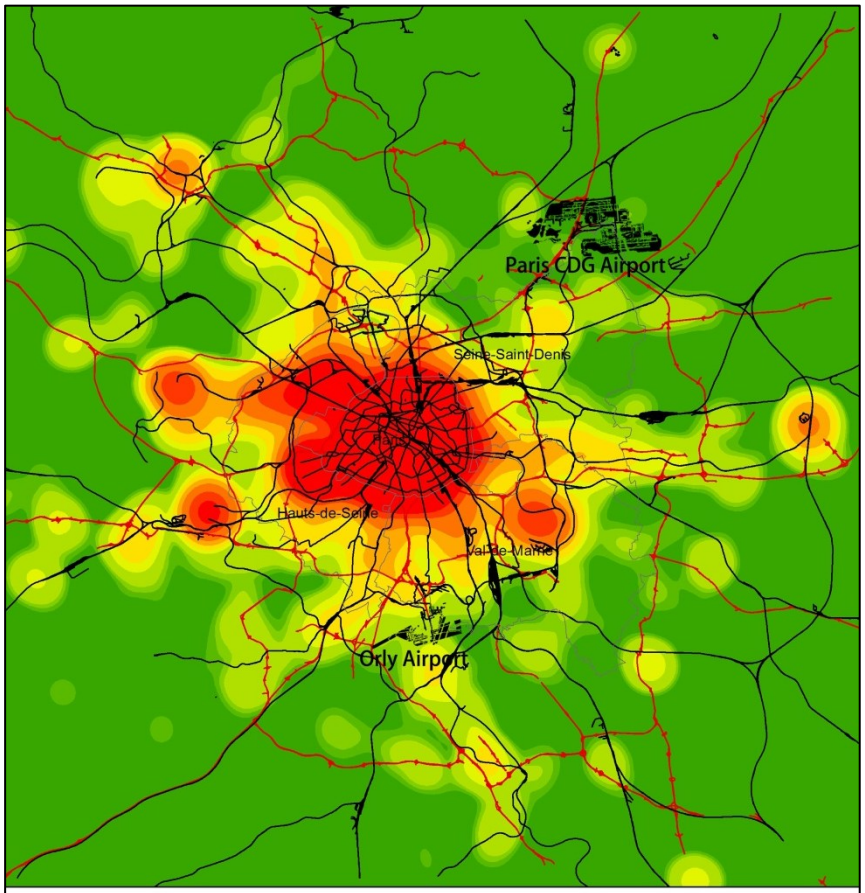

Paris CDG Airport
Seine-Saint-Denis
Paris
Hauts-de-Seine
Val-de-Marne
Orly Airport
Distribution of Higher Educational & Research Facilities in Paris
railway
motorway
Administrative Boundary
0 - 0,065
0,066 - 0,104
0,105 - 0,143
0,144 - 0,191
0,192 - 0,254
0,255 - 0,39
0,391 - 0,597
0,598 - 1,091
1,092 - 1,752
1,753 - 2,767



Distribution of Business & Industrial Areas in Paris

railway
motorway
Administrative Boundary

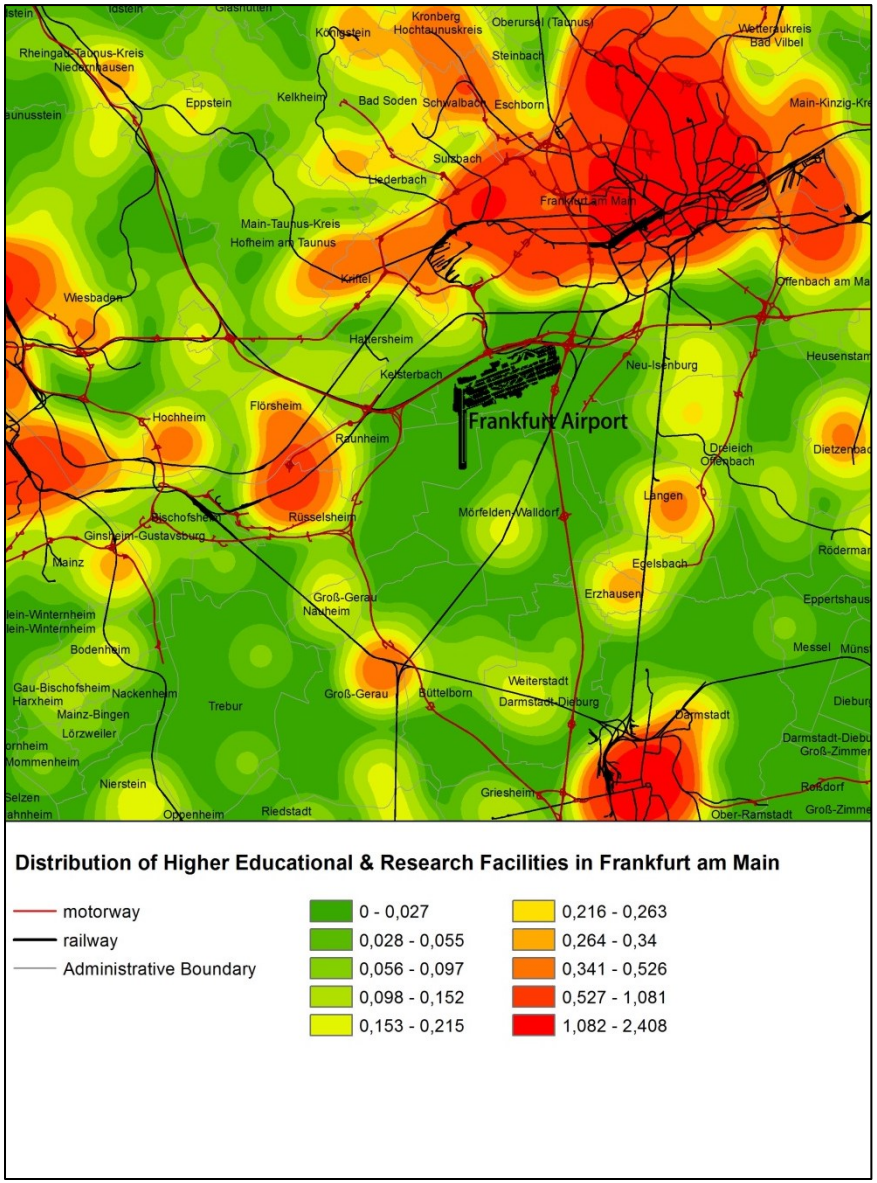
0 - 0,076	0,646 - 0,817
0,077 - 0,114	0,818 - 1,285
0,115 - 0,294	1,286 - 1,816
0,295 - 0,466	1,817 - 6,969
0,467 - 0,645	6,97 - 20,35

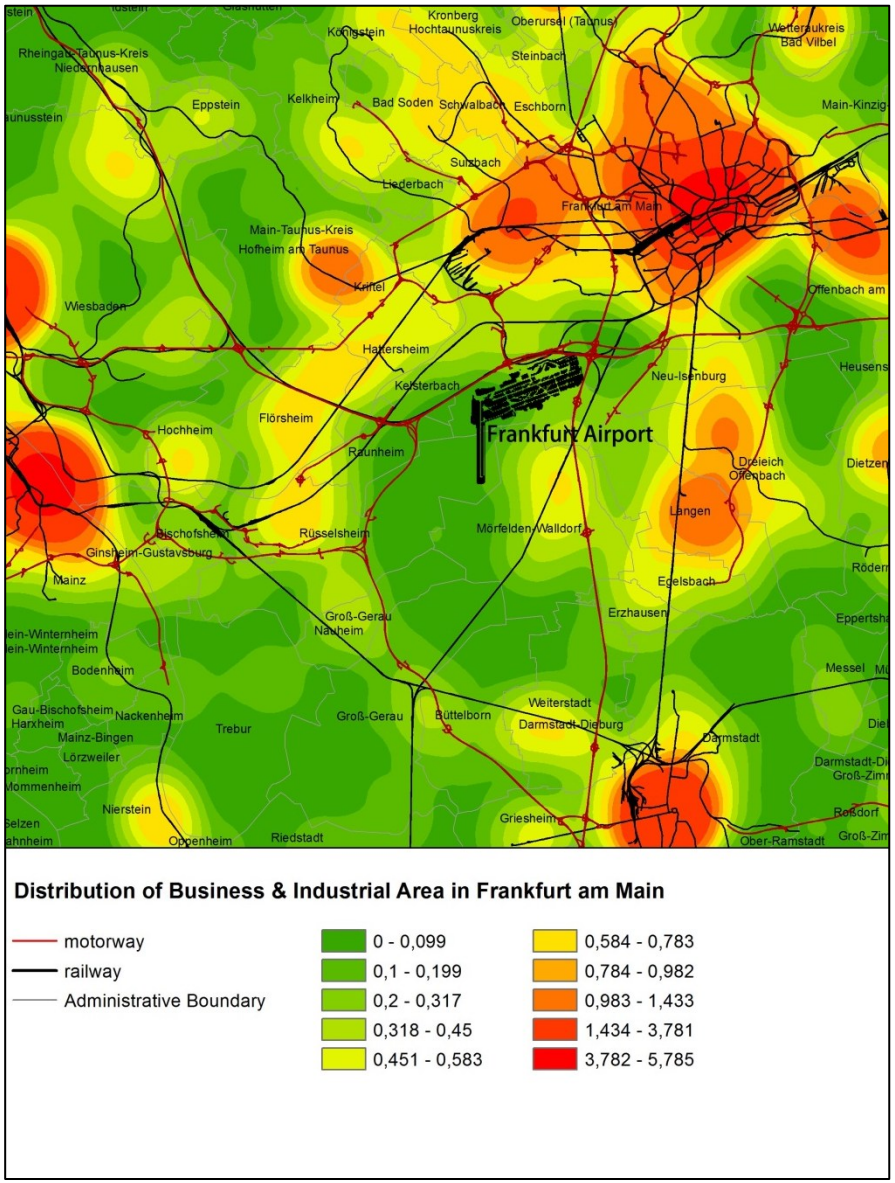


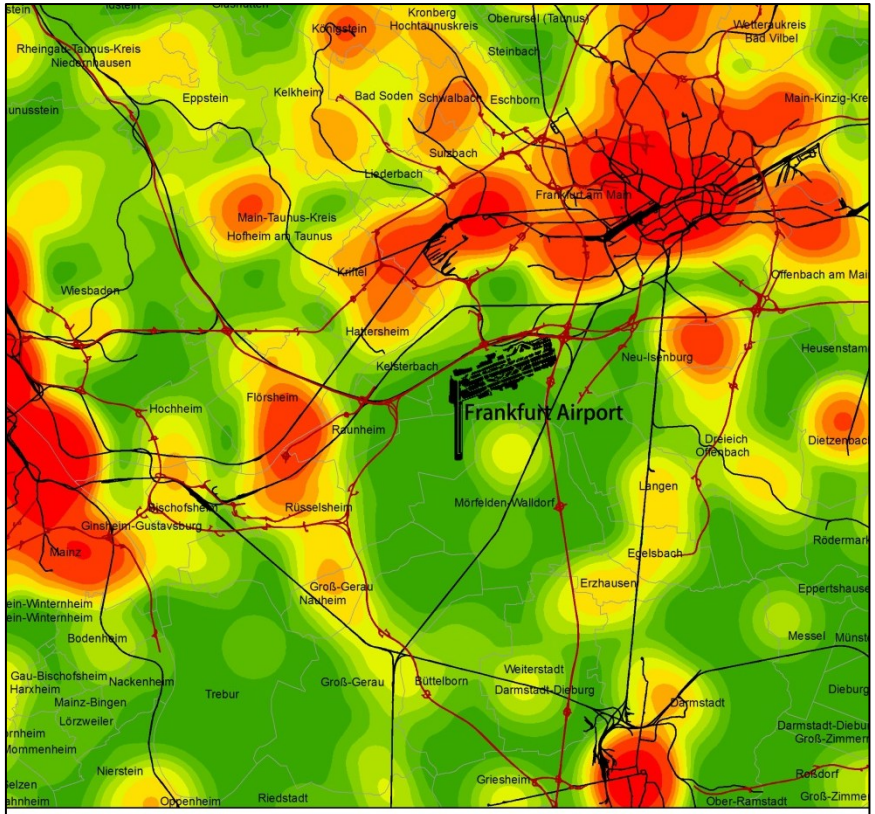
Distribution of Hospitality Facilities in Paris

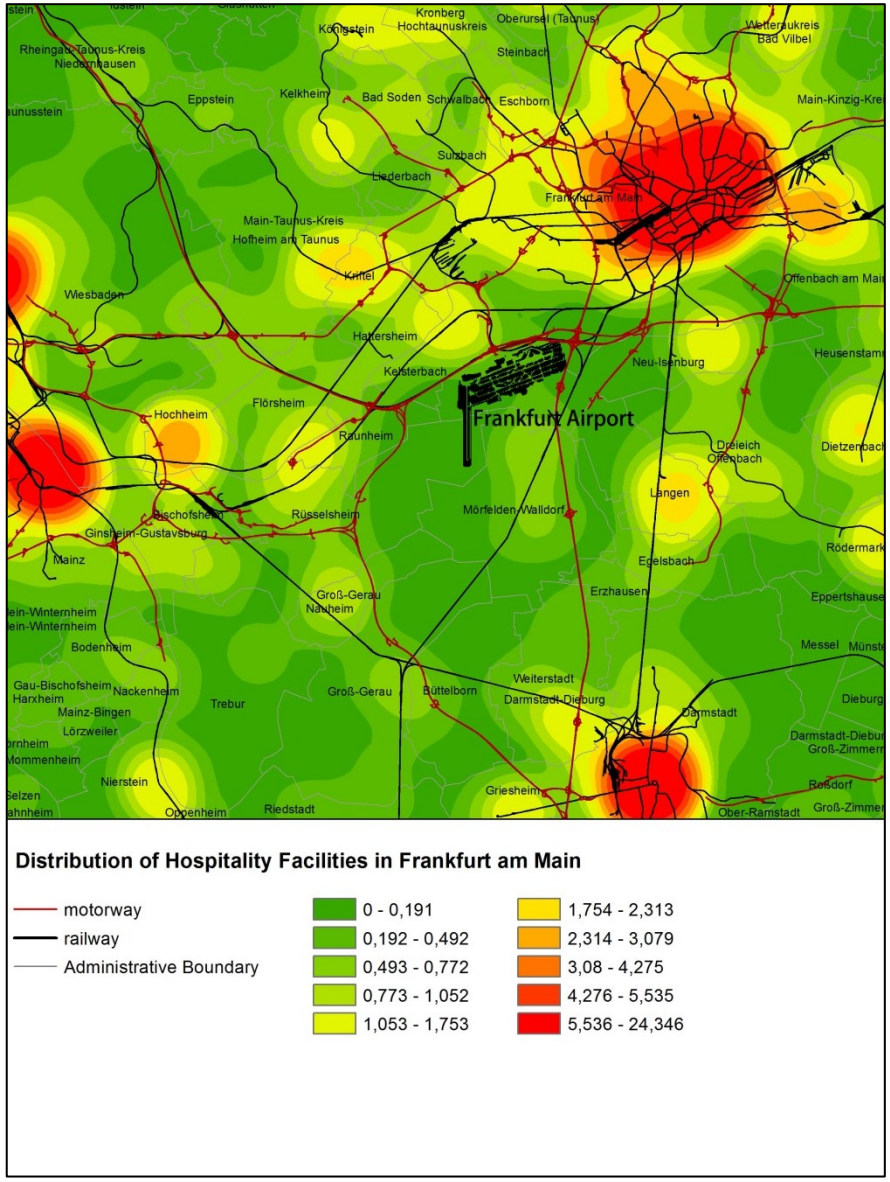
railway
motorway
Administrative Boundary

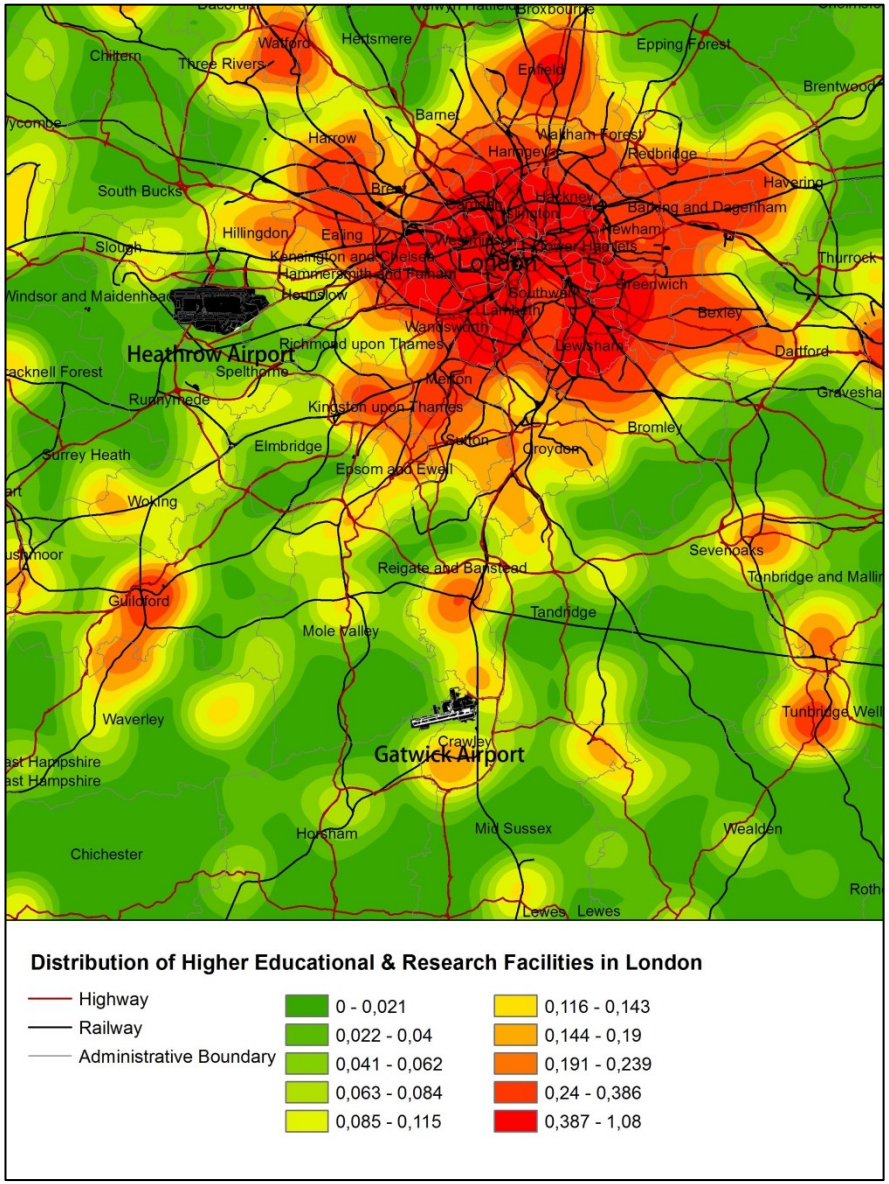
0 - 0,15	0,751 - 1,25
0,151 - 0,2	1,251 - 2
0,201 - 0,25	2,001 - 3,5
0,251 - 0,5	3,501 - 5
0,501 - 0,75	5,001 - 53,02

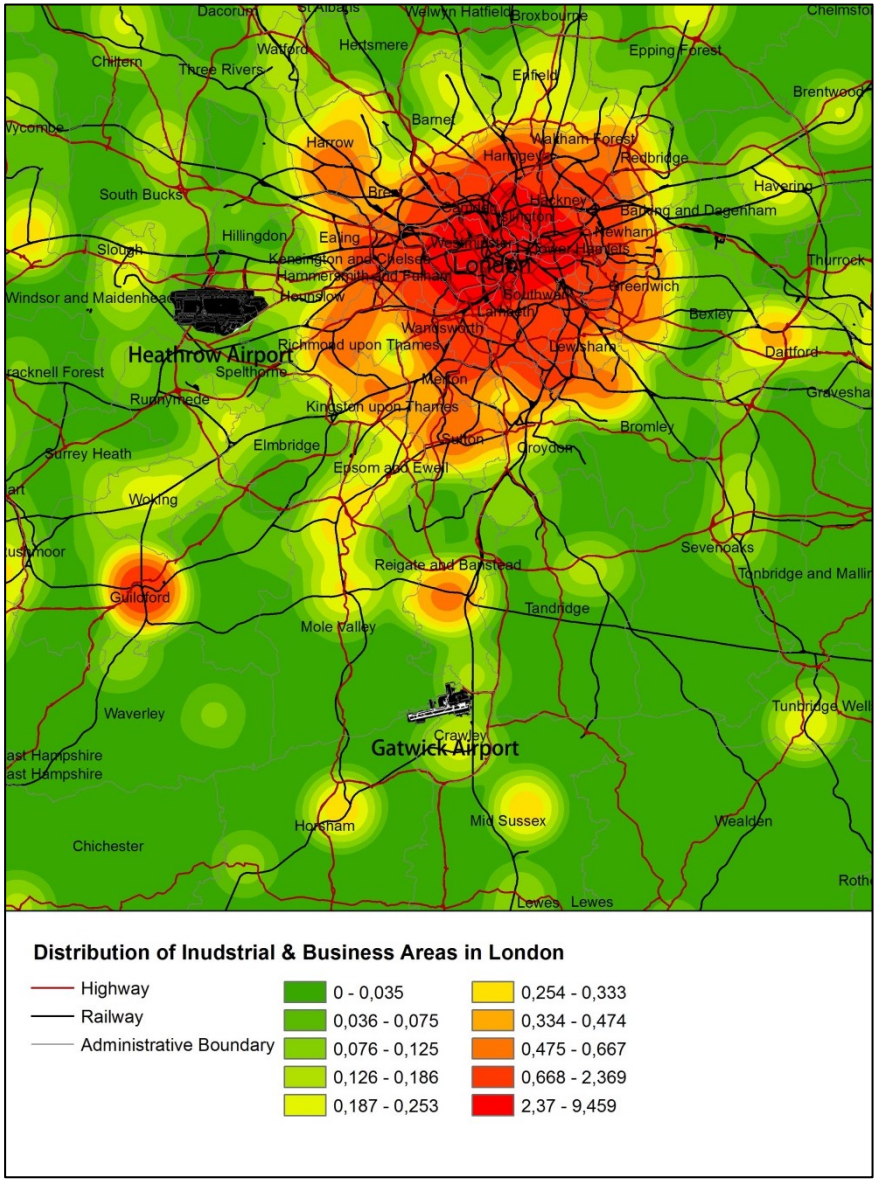

Kronberg
Hochtaunuskreis
Oberursel (Taunus)
Königstein
Wetteraukreis
Bad Vilbel
Rheingau-Taunus-Kreis
Niedernhausen
Steinbach
Eppstein
Kelkheim
Bad Soden
Schwalbach
Eschborn
Sulzbach
Liederbach
Frankfurt am Main
Main-Taunus-Kreis
Hofheim am Taunus
Kriftel
Wiesbaden
Hattersheim
Kelsterbach
Neu-Isenburg
Frankfurt Airport
Hochheim
Flörsheim
Raunheim
Dreieich
Offenbach
Langen
Mörfelden-Walldorf
Rüsselsheim
Bischofsheim
Ginsheim-Gustavsburg
Mainz
Egelsbach
Erzhausen
Groß-Gerau
Nauheim
Bodenheim
Messel
Gau-Bischofsheim
Harxheim
Nackenheim
Trebur
Büttelborn
Weiterstadt
Darmstadt-Dieburg
Darmstadt
Mainz-Bingen
Lörzweiler
Nierstein
Oppenheim
Riedstadt
Griesheim
Ober-Ramstadt
Distribution of Higher Educational & Research Facilities in Frankfurt am Main
motorway
railway
Administrative Boundary
0 - 0,027
0,028 - 0,055
0,056 - 0,097
0,098 - 0,152
0,153 - 0,215
0,216 - 0,263
0,264 - 0,34
0,341 - 0,526
0,527 - 1,081
1,082 - 2,408

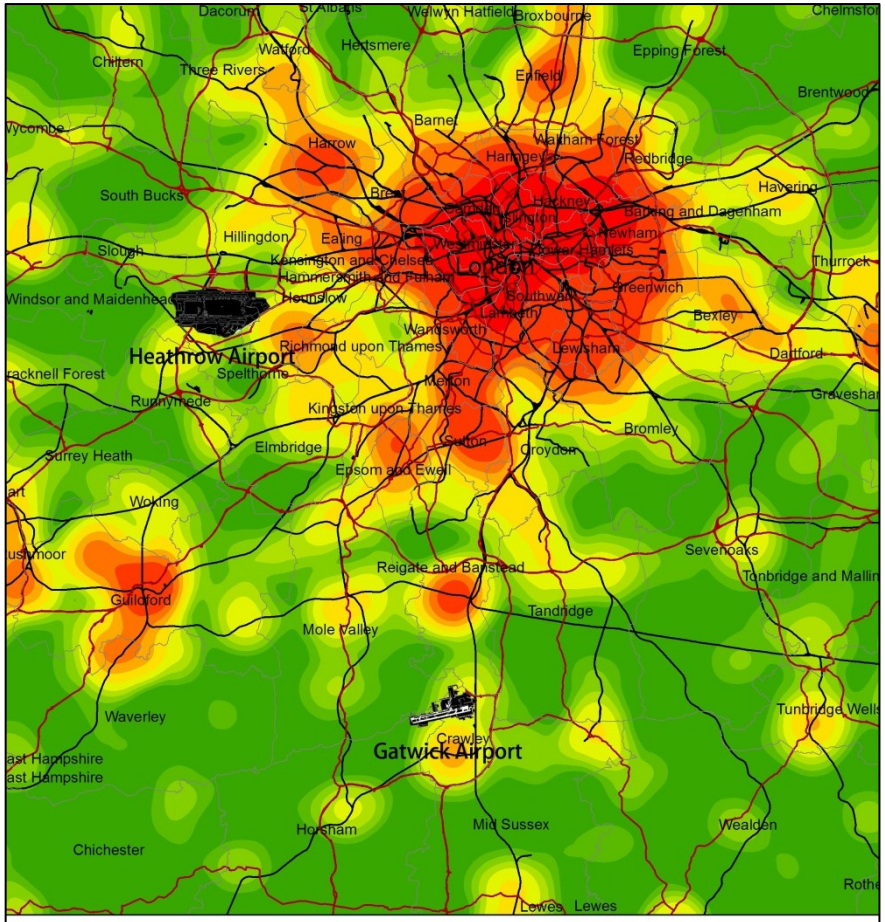

Kronberg
Hochtaunuskreis
Oberursel (Taunus)
Königstein
Wetteraukreis
Bad Vilbel
Rheingau-Taunus-Kreis
Niedernhausen
Steinbach
Eppstein
Kelkheim
Bad Soden
Schwalbach
Eschborn
Sulzbach
Liederbach
Frankfurt am Main
Main-Taunus-Kreis
Hofheim am Taunus
Kriftel
Wiesbaden
Hattersheim
Kelsterbach
Neu-Isenburg
Frankfurt Airport
Hochheim
Flörsheim
Raunheim
Dreieich
Offenbach
Langen
Mörfelden-Walldorf
Rüsselsheim
Bischofsheim
Ginsheim-Gustavsburg
Mainz
Egelsbach
Erzhausen
Groß-Gerau
Nauheim
Bodenheim
Messel
Gau-Bischofsheim
Harxheim
Nackenheim
Trebur
Büttelborn
Weiterstadt
Darmstadt-Dieburg
Darmstadt
Mainz-Bingen
Lörzweiler
Nierstein
Oppenheim
Riedstadt
Griesheim
Ober-Ramstadt
Distribution of Business & Industrial Area in Frankfurt am Main
motorway
railway
Administrative Boundary
0 - 0,099
0,1 - 0,199
0,2 - 0,317
0,318 - 0,45
0,451 - 0,583
0,584 - 0,783
0,784 - 0,982
0,983 - 1,433
1,434 - 3,781
3,782 - 5,785

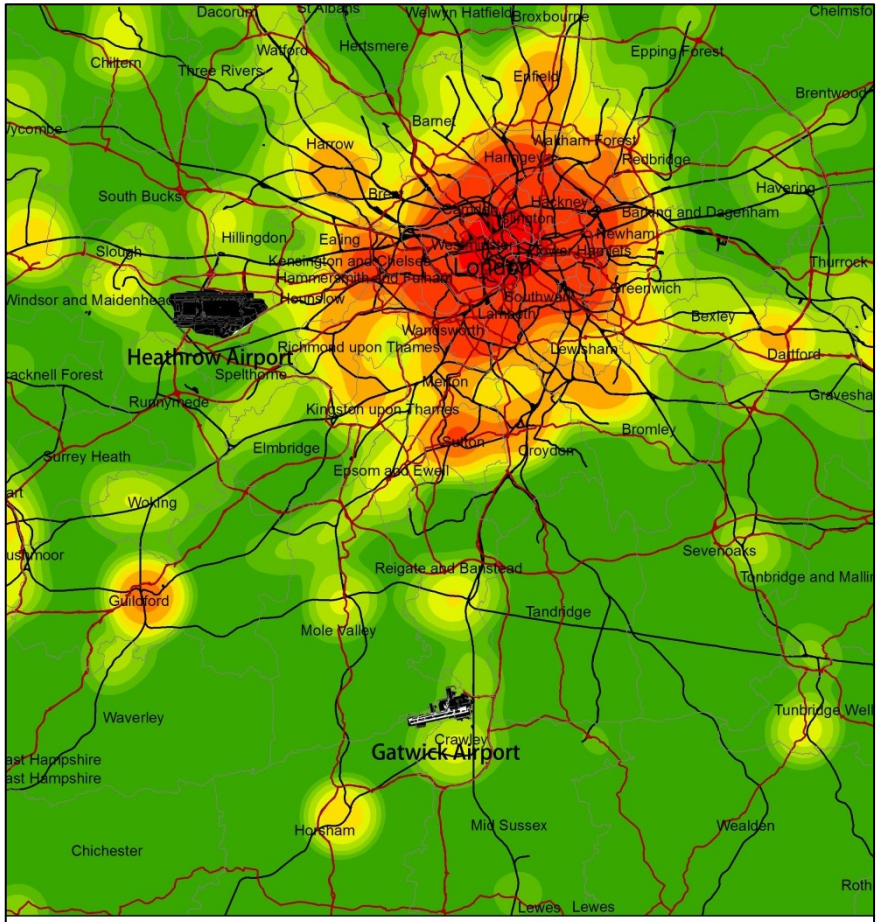

Kronberg
Hochtaunuskreis
Oberursel (Taunus)
Königstein
Wetteraukreis
Bad Vilbel
Rheingau-Taunus-Kreis
Niedernhausen
Steinbach
Eppstein
Kelkheim
Bad Soden
Schwalbach
Eschborn
Main-Kinzig-Kre
Sulzbach
Liederbach
Frankfurt am Main
Main-Taunus-Kreis
Hofheim am Taunus
Kriftel
Offenbach am Mai
Wiesbaden
Hattersheim
Kelsterbach
Neu-Isenburg
Heusenstam
Flörsheim
Hochheim
Raunheim
Frankfurt Airport
Dreieich
Offenbach
Dietzenbac
Langen
Mörfelden-Walldorf
Rüsselsheim
Bischofsheim
Ginsheim-Gustavsburg
Mainz
Rödermar
Egelsbach
Erzhausen
Groß-Gerau
Nauheim
Eppertshause
Bodenheim
Messel
Münst
Gau-Bischofsheim
Harxheim
Nackenheim
Trebur
Groß-Gerau
Büttelborn
Weiterstadt
Darmstadt-Dieburg
Dieburg
Darmstadt
Mainz-Bingen
Lörzweiler
Darmstadt-Diebur
Groß-Zimmern
Nierstein
Griesheim
Roßdorf
Oppenheim
Riedstadt
Ober-Ramstadt
Groß-Zimme
Distribution of Social Service Facilities in Frankfurt am Main
motorway
railway
Administrative Boundary
0 - 0,026
0,027 - 0,057
0,058 - 0,08
0,081 - 0,111
0,112 - 0,145
0,146 - 0,195
0,196 - 0,244
0,245 - 0,297
0,298 - 0,446
0,447 - 1,326

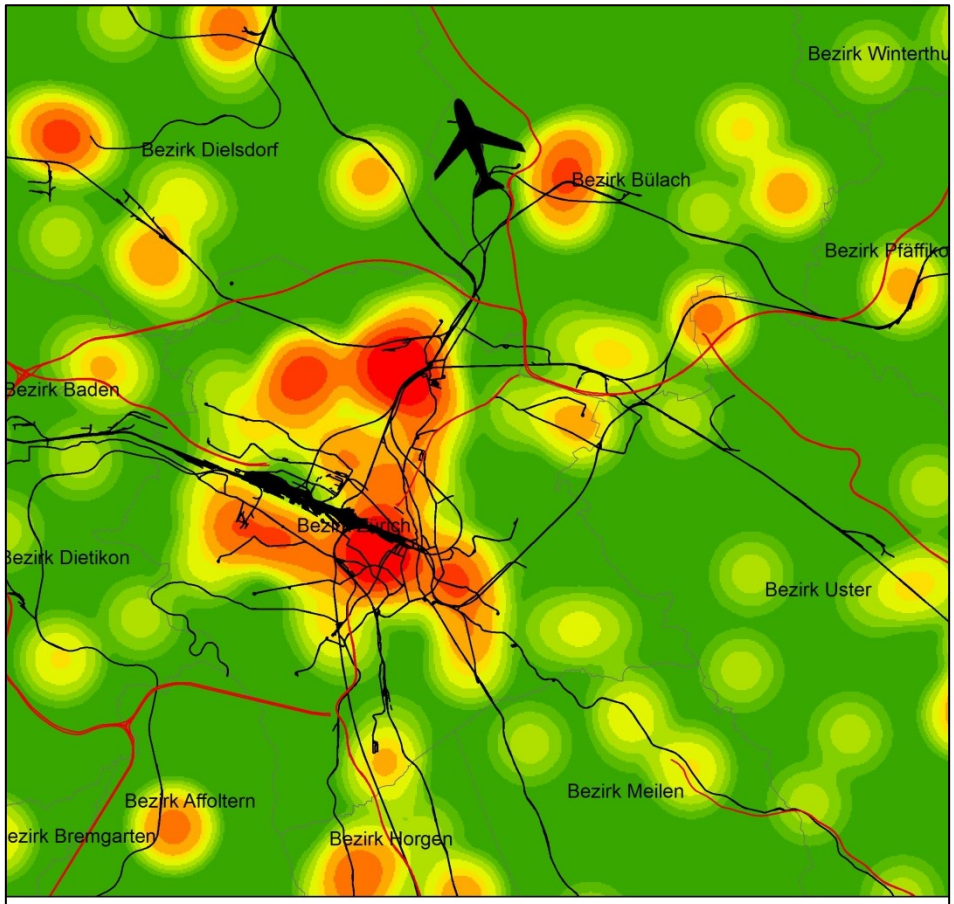

Kronberg
Hochtaunuskreis
Oberursel (Taunus)
Königstein
Wetteraukreis
Bad Vilbel
Rheingau-Taunus-Kreis
Niedernhausen
Steinbach
Eppstein
Kelkheim
Bad Soden
Schwalbach
Eschborn
Main-Kinzig-Kre
Sulzbach
Liederbach
Frankfurt am Main
Main-Taunus-Kreis
Hofheim am Taunus
Kriftel
Offenbach am Mai
Wiesbaden
Hattersheim
Kelsterbach
Neu-Isenburg
Heusenstam
Flörsheim
Hochheim
Raunheim
Frankfurt Airport
Dreieich
Offenbach
Dietzenbac
Langen
Mörfelden-Walldorf
Rüsselsheim
Bischofsheim
Ginsheim-Gustavsburg
Mainz
Rödermark
Egelsbach
Erzhausen
Groß-Gerau
Nauheim
Eppertshause
Bodenheim
Messel
Gau-Bischofsheim
Harxheim
Nackenheim
Trebur
Groß-Gerau
Büttelborn
Weiterstadt
Darmstadt-Dieburg
Dieburg
Darmstadt
Mainz-Bingen
Lörzweiler
Darmstadt-Diebur
Groß-Zimmern
Nierstein
Griesheim
Roßdorf
Oppenheim
Riedstadt
Ober-Ramstadt
Distribution of Hospitality Facilities in Frankfurt am Main
motorway
railway
Administrative Boundary
0 - 0,191
0,192 - 0,492
0,493 - 0,772
0,773 - 1,052
1,053 - 1,753
1,754 - 2,313
2,314 - 3,079
3,08 - 4,275
4,276 - 5,535
5,536 - 24,346


Distribution of Higher Educational & Research Facilities in London
Highway
Railway
Administrative Boundary
0 - 0,021
0,022 - 0,04
0,041 - 0,062
0,063 - 0,084
0,085 - 0,115
0,116 - 0,143
0,144 - 0,19
0,191 - 0,239
0,24 - 0,386
0,387 - 1,08
Heathrow Airport
Gatwick Airport
London


Distribution of Inudstrial & Business Areas in London
Highway
Railway
Administrative Boundary
0 - 0,035
0,036 - 0,075
0,076 - 0,125
0,126 - 0,186
0,187 - 0,253
0,254 - 0,333
0,334 - 0,474
0,475 - 0,667
0,668 - 2,369
2,37 - 9,459
Heathrow Airport
Gatwick Airport
London


Heathrow Airport
Gatwick Airport
London
Distribution ofSocial Service Facilities in London
Highway
Railway
Administrative Boundary
0 - 0,029
0,03 - 0,042
0,043 - 0,058
0,059 - 0,076
0,077 - 0,105
0,106 - 0,14
0,141 - 0,171
0,172 - 0,21
0,211 - 0,361
0,362 - 0,915


Heathrow Airport
Gatwick Airport
London
Distribution of Hospitality Facilities in London
Highway
Railway
Administrative Boundary
0 - 0,21
0,211 - 0,32
0,321 - 0,45
0,451 - 0,65
0,651 - 0,87
0,871 - 1,21
1,211 - 1,739
1,74 - 2,243
2,244 - 15,336
15,337 - 34,695

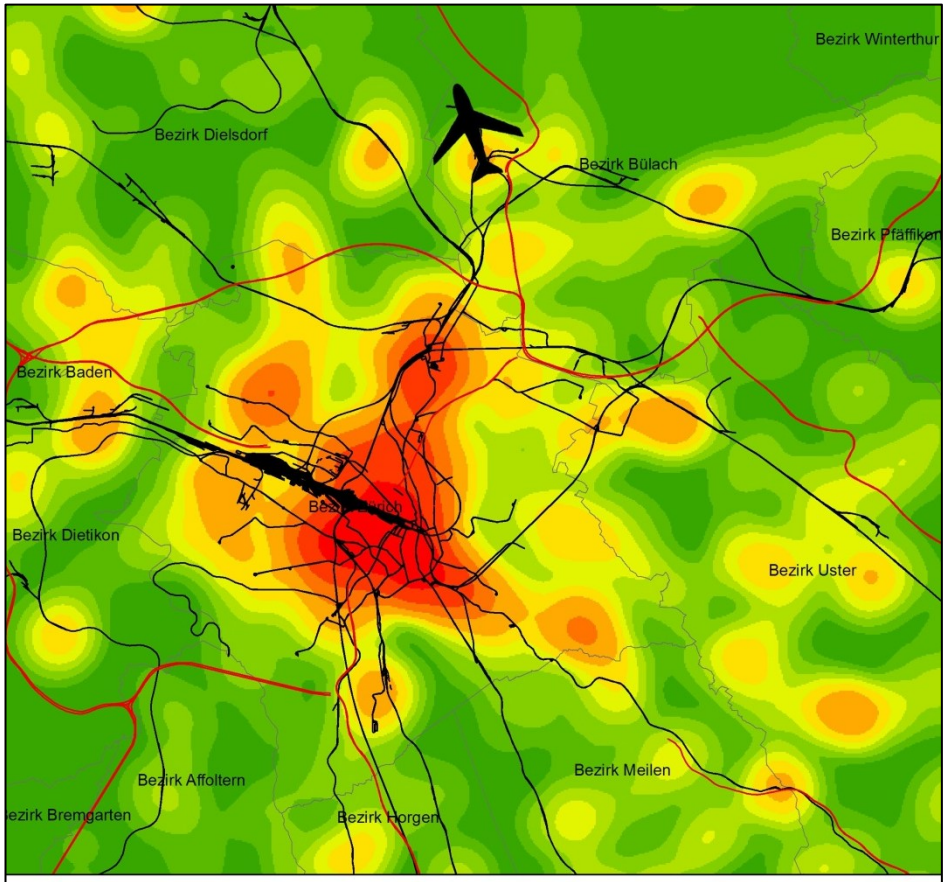


Distribution of Higher Educational & Research Facilities in Zurich

Legend

- Highway
- Railway
- Administrative Boundary

0 - 0,0555	0,498 - 0,619
0,0556 - 0,13	0,62 - 0,897
0,131 - 0,212	0,898 - 1,26
0,213 - 0,334	1,27 - 1,7
0,335 - 0,497	1,71 - 2,83

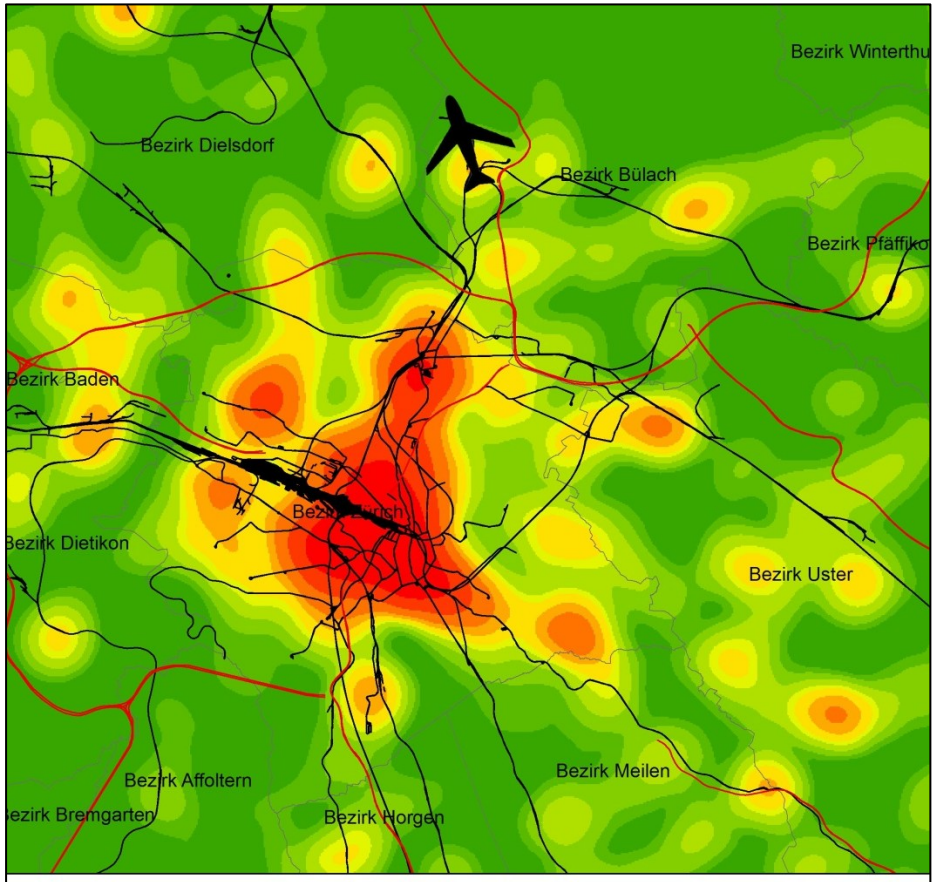


Distribution of Business & Industrial Land Use in Zurich

Legend

- Highway
- Railway
- Administrative Boundary

0 - 0,219	1,77 - 2,39
0,22 - 0,51	2,4 - 3,65
0,511 - 0,902	3,66 - 5,37
0,903 - 1,29	5,38 - 8,23
1,3 - 1,76	8,24 - 13,9

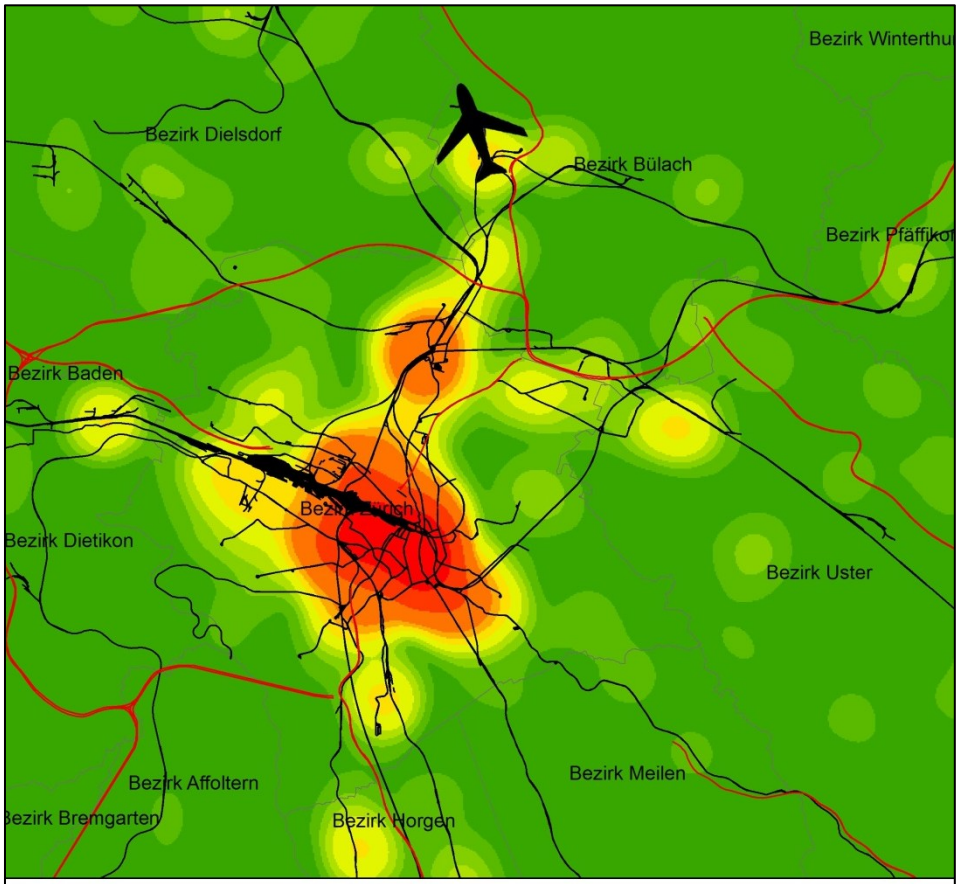


Distribution of Social Service Facilities in Zurich

Legend

- Highway
- Railway
- Administrative Boundary

0 - 0,468	2,01 - 2,58
0,469 - 0,745	2,59 - 3,21
0,746 - 1,17	3,22 - 4,74
1,18 - 1,69	4,75 - 7,14
1,7 - 2	7,15 - 13,9

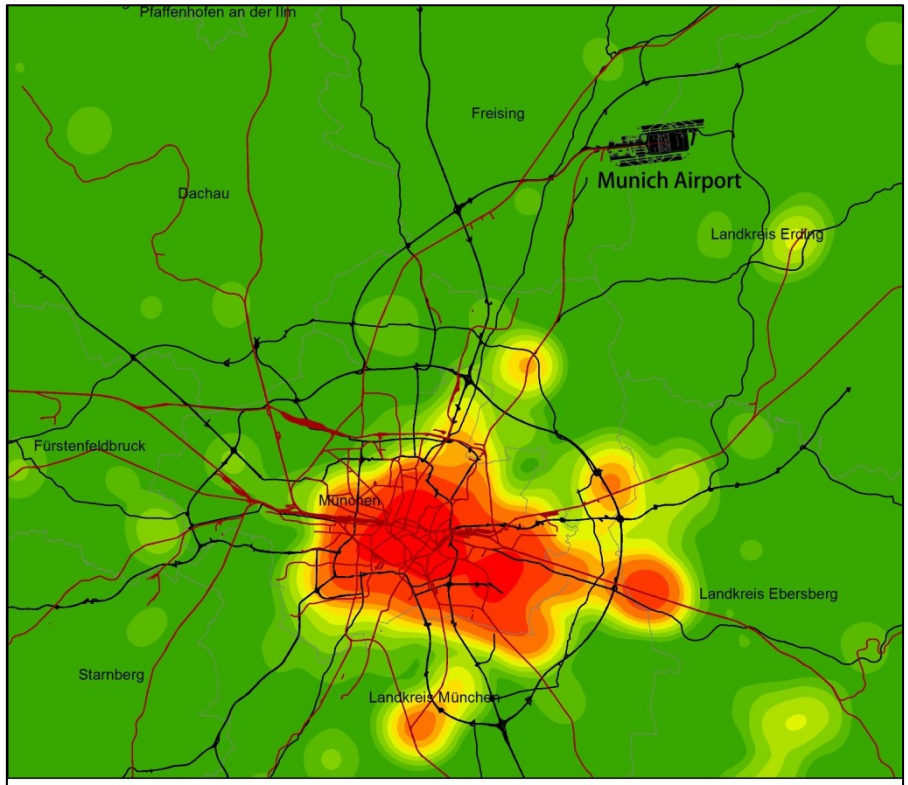


Distribution of Hospitality Facilities in Zurich

Legend

- Highway
- Railway
- Administrative Boundary

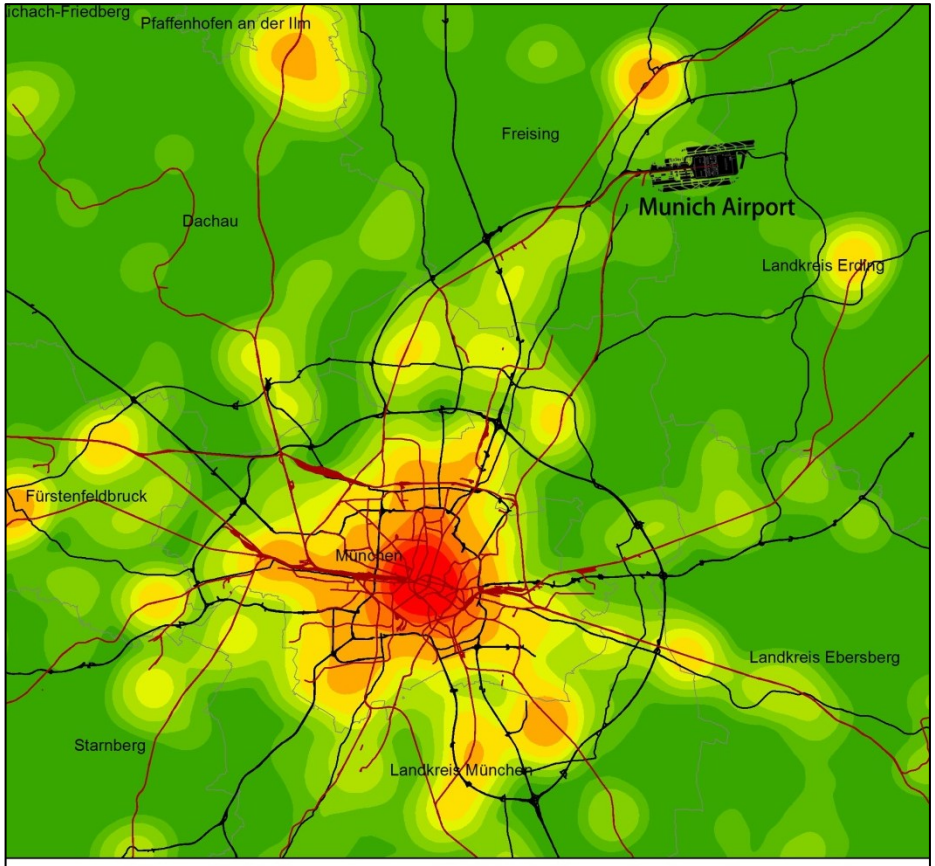
0 - 0,468	2,01 - 2,58
0,469 - 0,745	2,59 - 3,21
0,746 - 1,17	3,22 - 4,74
1,18 - 1,69	4,75 - 7,14
1,7 - 2	7,15 - 13,9



Density of Higher Education & Research Facilities in Munich

Railway
Motorway
Administrative Boundary

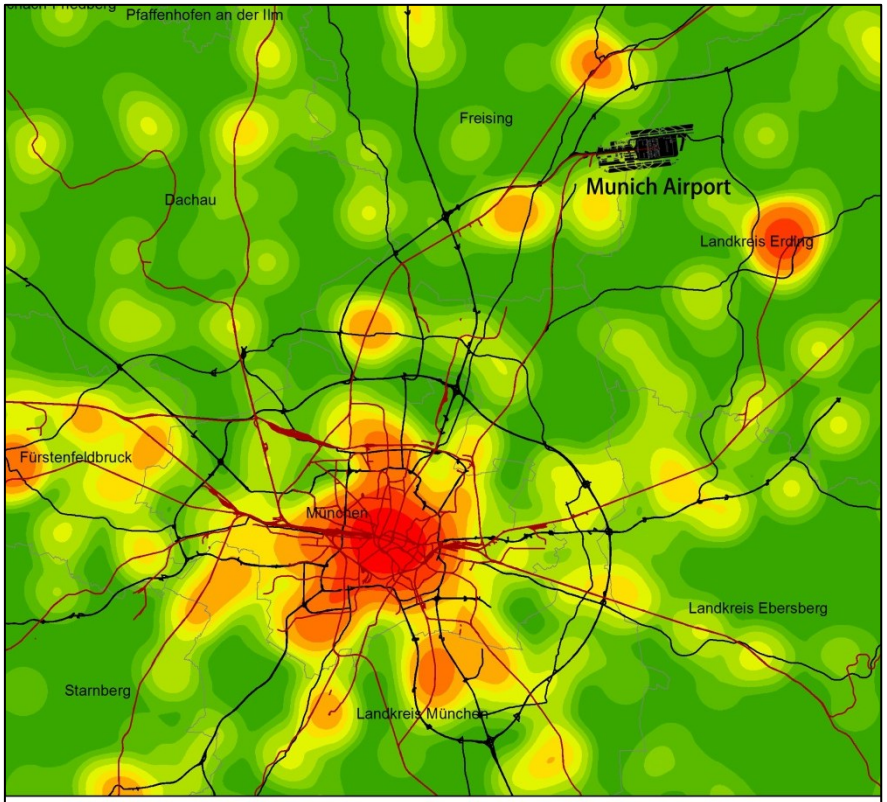
0 - 0,0779	0,61 - 0,799
0,078 - 0,172	0,8 - 1,03
0,173 - 0,304	1,04 - 1,64
0,305 - 0,456	1,65 - 3,37
0,457 - 0,609	3,38 - 6,62



Density of Bussiness & Commercial Land Use in Munich

Railway
Motorway
Administrative Boundary

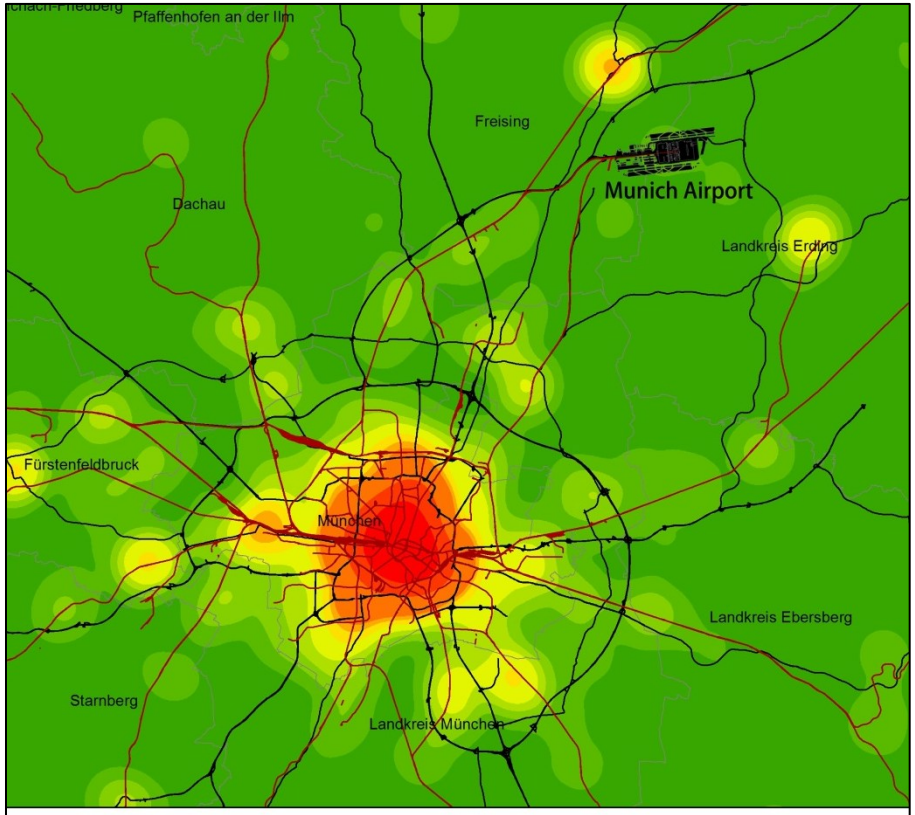
0 - 0,137	0,972 - 1,44
0,138 - 0,266	1,45 - 2,98
0,267 - 0,467	2,99 - 4,99
0,468 - 0,734	5 - 6,73
0,735 - 0,971	6,74 - 11,6



Density of Social Service Facilities in Munich

- Railway
- Motorway
- Administrative Boundary

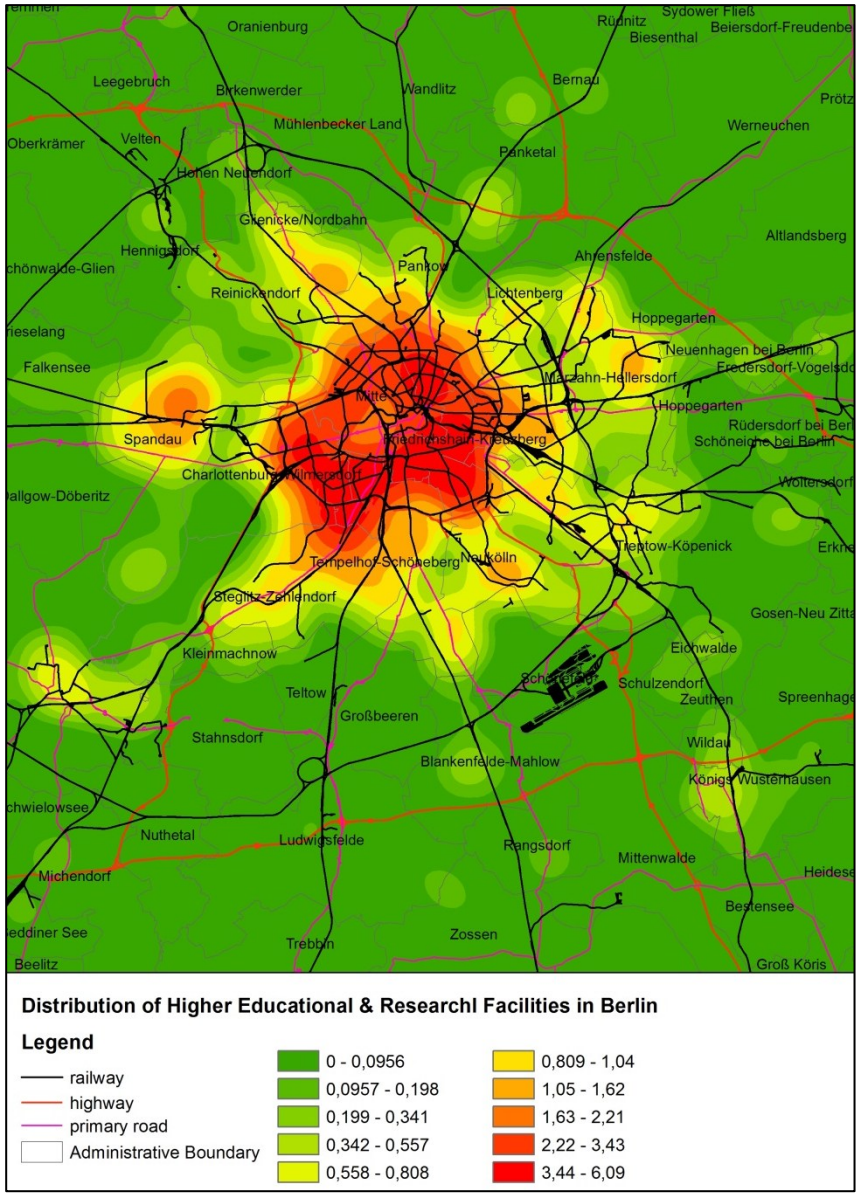
0 - 0,0267	0,19 - 0,242
0,0268 - 0,0589	0,243 - 0,346
0,059 - 0,0911	0,347 - 0,581
0,0912 - 0,137	0,582 - 1,18
0,138 - 0,189	1,19 - 2,27

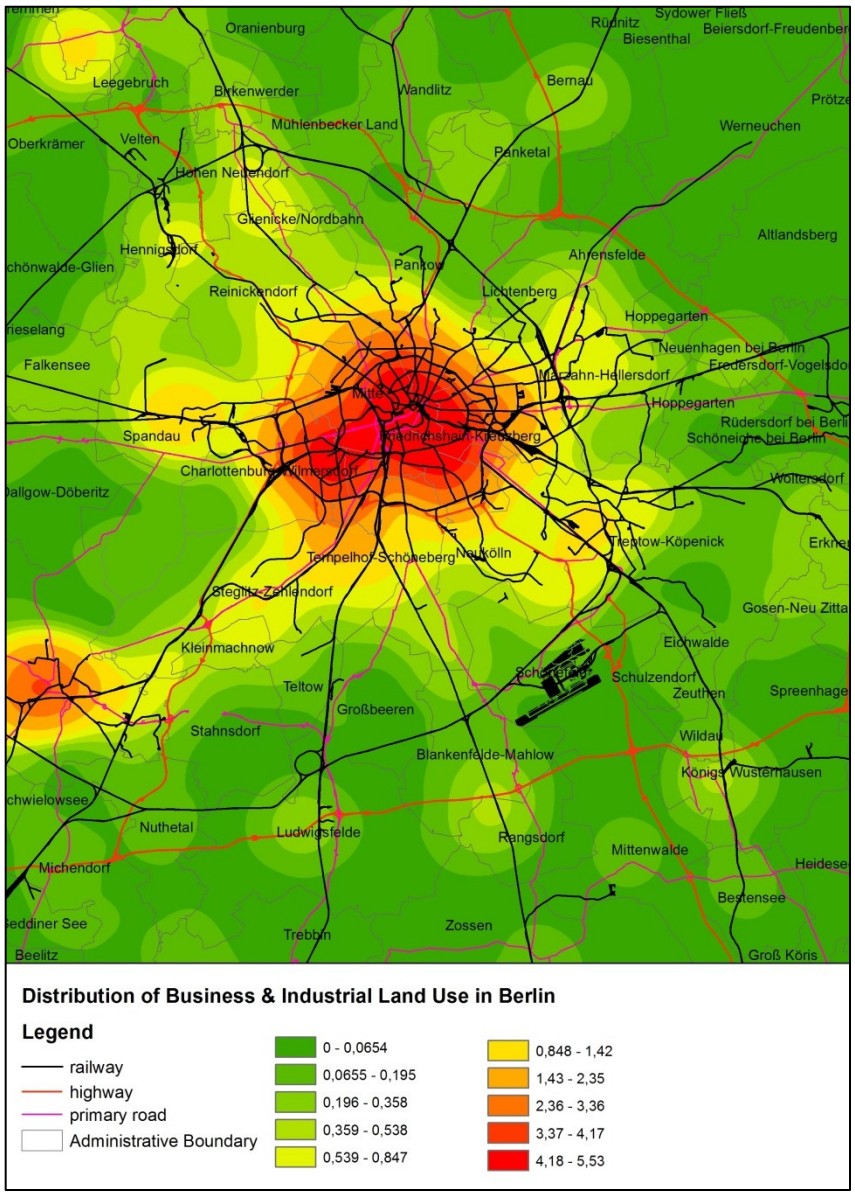


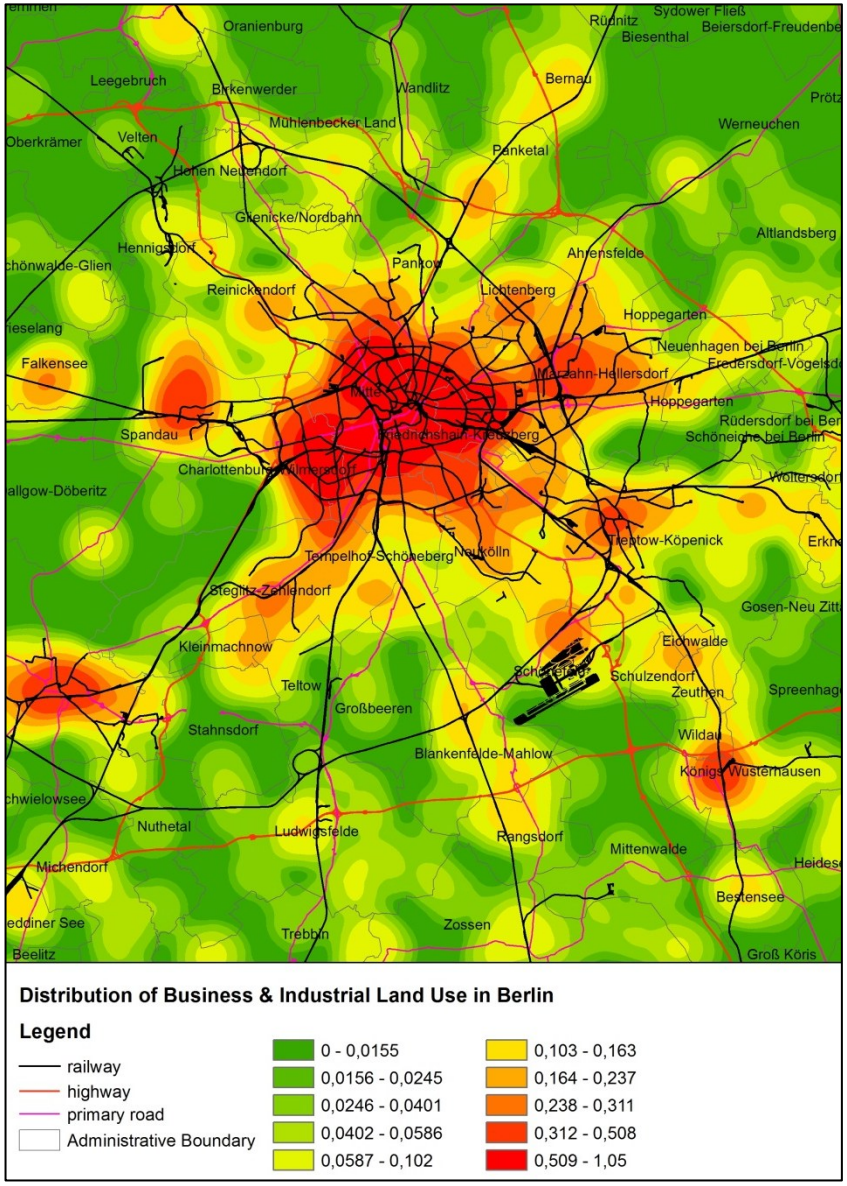
Density of Hospitality Facilities in Munich

- Railway
- Motorway
- Administrative Boundary

0 - 0,328	2,66 - 3,37
0,329 - 0,846	3,38 - 3,98
0,847 - 1,33	3,99 - 10,2
1,34 - 1,81	10,3 - 20,5
1,82 - 2,65	20,6 - 41,9


Oranienburg
Rüdnitz
Sydower Fließ
Biesenthal
Beiersdorf-Freudenberg
Leegebruch
Birkenwerder
Wandlitz
Bernau
Prötzel
Mühlenbecker Land
Werneuchen
Oberkrämer
Velten
Panketal
Hohen Neuendorf
Glienicke/Nordbahn
Hennigsdorf
Altlandsberg
Schönwalde-Glien
Pankow
Ahrensfelde
Reinickendorf
Lichtenberg
Hoppegarten
Neuenhagen bei Berlin
Falkensee
Marzahn-Hellersdorf
Fredersdorf-Vogelsdorf
Mitte
Rüdersdorf bei Berlin
Spandau
Friedrichshain-Kreuzberg
Schöneiche bei Berlin
Charlottenburg-Wilmersdorf
Woltersdorf
Treptow-Köpenick
Tempelhof-Schöneberg
Neukölln
Steglitz-Zehlendorf
Gosen-Neu Zittau
Kleinmachnow
Eichwalde
Schönefeld
Teltow
Schulzendorf
Zeuthen
Spreenhagen
Großbeeren
Stahnsdorf
Wildau
Blankenfelde-Mahlow
Königs Wusterhausen
Nuthetal
Ludwigsfelde
Rangsdorf
Mittenwalde
Michendorf
Heidesee
Bestensee
Trebbin
Zossen
Beelitz
Groß Köris
Distribution of Higher Educational & Researchl Facilities in Berlin
Legend
railway
highway
primary road
Administrative Boundary
0 - 0,0956
0,0957 - 0,198
0,199 - 0,341
0,342 - 0,557
0,558 - 0,808
0,809 - 1,04
1,05 - 1,62
1,63 - 2,21
2,22 - 3,43
3,44 - 6,09


Oranienburg
Rüdnitz
Sydower Fließ
Biesenthal
Beiersdorf-Freudenberg
Leegebruch
Birkenwerder
Wandlitz
Bernau
Prötzel
Mühlenbecker Land
Werneuchen
Oberkrämer
Velten
Panketal
Hohen Neuendorf
Glienicke/Nordbahn
Hennigsdorf
Altlandsberg
Schönwalde-Glien
Pankow
Ahrensfelde
Reinickendorf
Lichtenberg
Hoppegarten
Neuenhagen bei Berlin
Falkensee
Marzahn-Hellersdorf
Fredersdorf-Vogelsdorf
Mitte
Rüdersdorf bei Berlin
Spandau
Friedrichshain-Kreuzberg
Schöneiche bei Berlin
Charlottenburg-Wilmersdorf
Woltersdorf
Treptow-Köpenick
Tempelhof-Schöneberg
Neukölln
Steglitz-Zehlendorf
Gosen-Neu Zittau
Kleinmachnow
Eichwalde
Schönefeld
Teltow
Schulzendorf
Zeuthen
Spreenhagen
Großbeeren
Stahnsdorf
Wildau
Blankenfelde-Mahlow
Königs Wusterhausen
Nuthetal
Ludwigsfelde
Rangsdorf
Mittenwalde
Michendorf
Heidesee
Bestensee
Trebbin
Zossen
Beelitz
Groß Köris
Distribution of Business & Industrial Land Use in Berlin
Legend
railway
highway
primary road
Administrative Boundary
0 - 0,0654
0,0655 - 0,195
0,196 - 0,358
0,359 - 0,538
0,539 - 0,847
0,848 - 1,42
1,43 - 2,35
2,36 - 3,36
3,37 - 4,17
4,18 - 5,53

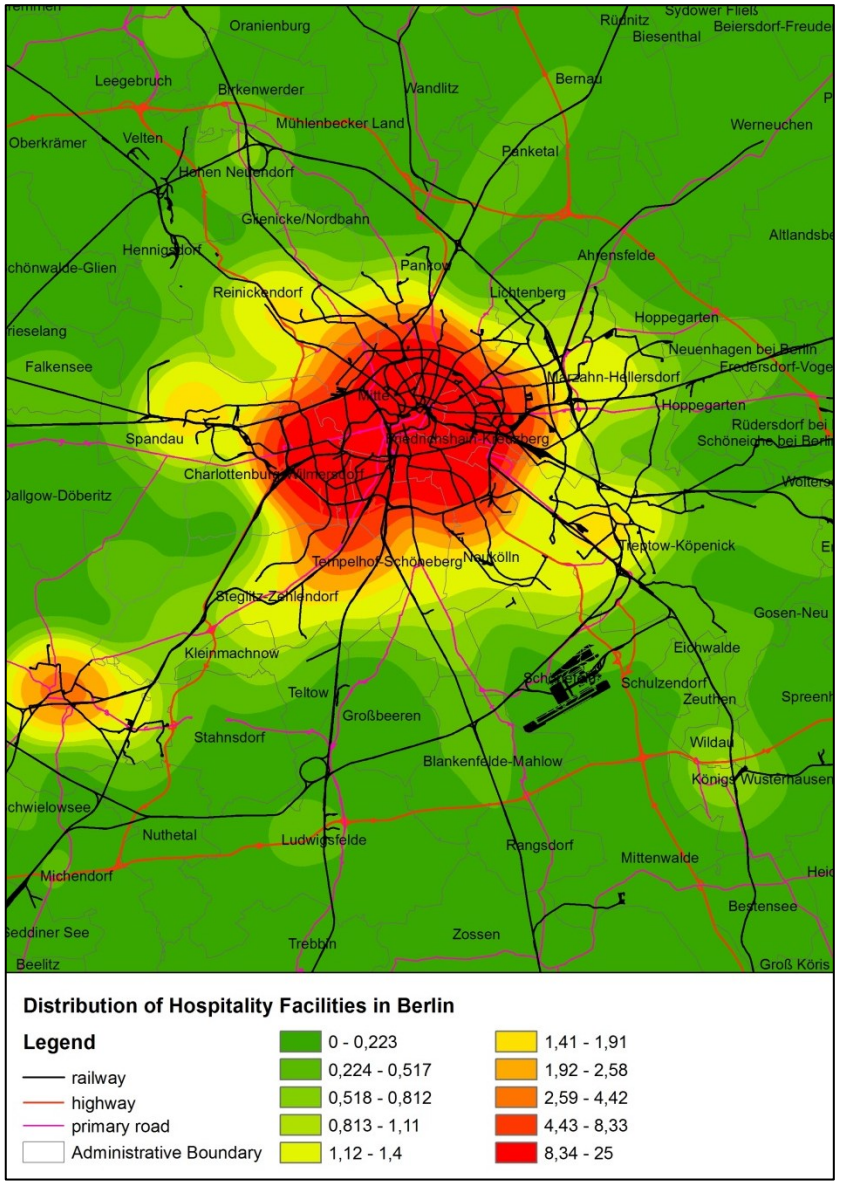


Distribution of Business & Industrial Land Use in Berlin

Legend

- railway
- highway
- primary road
- Administrative Boundary

0 - 0,0155	0,103 - 0,163
0,0156 - 0,0245	0,164 - 0,237
0,0246 - 0,0401	0,238 - 0,311
0,0402 - 0,0586	0,312 - 0,508
0,0587 - 0,102	0,509 - 1,05



Distribution of Hospitality Facilities in Berlin

Legend

- railway
- highway
- primary road
- Administrative Boundary

0 - 0,223	1,41 - 1,91
0,224 - 0,517	1,92 - 2,58
0,518 - 0,812	2,59 - 4,42
0,813 - 1,11	4,43 - 8,33
1,12 - 1,4	8,34 - 25